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Emulsified Asphalt Retread Surfacing, Fortune Lake Park, Mich.

Road Mix

Coarse Aggregate Type

Using Emulsified Asphalt

Recent Practical Developments

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THE purpose of this discussion is to compare construction methods where emulsified asphalt is used with those described by the committee on Low Cost Roads, of the American Road Builders Association, for use with tars and cut-backs. In emulsified asphalt construction, as with other binders described by the committee on Low Cost Roads, there are two distinct types of road mix—one, involving the use of continuously graded aggregate, including dust; and the other with open graded material. Both types have been successful and the relative suitability of either type depends entirely on local conditions. It has become more or less general practice to refer to the type containing fine material and dust as "Road Mix," and the coarse aggregate type as "Retread." This discussion will be confined entirely to the latter type.

Emulsified asphalt has come into extensive use as a road building material and many miles of retread (coarse aggregate road mix), of thicknesses ranging from 1 in. to 2½ in. have been constructed over old treated and untreated surfaces using emulsified asphalt as a binder. The cost of this type of work is usually well within the limit of 50 cts. per square yard mentioned in the committee's report—a 1 in. to 1½ in. thickness usually ranging from 28 cts. to 35 cts per sq. yd.

The report of the committee has very accurately described construction materials and standard construction practices in retread work in which tars and cut-back asphalts are used.

Thickness.—The thickness should depend largely on

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the character of the base. Where the base consists of an old road previously treated and not too irregular in surface, a retread having a finished thickness of 1¼ in. to 1½ in. seems to be most economical and has been found to be very durable. Where the base consists of untreated gravel, or other metal not well compacted, or where the base requires considerable re-shaping prior to the construction of the retread, engineers generally seem to favor a finished thickness of 2 in. for the retread surface. Thicknesses less than 1¼ in. should usually be preceded by a tack coat, or primer, as is described in the committee's report—the quantity of primer depending upon the condition of the surface, ⅛ gal. per sq. yd. usually being sufficient on bituminous treated work, and ¼ to 1/3 gal. on untreated base surfaces.

MATERIALS

Aggregate.—In emulsified asphalt construction the same considerations apply regarding quality of aggregate as when other binders are used. It is, however, questionable whether lines should be too tightly drawn as to percentage of wear, shape of particles, uniformity, etc. The retread type of work, to be economical, should utilize locally available and inexpensive material whenever possible. Properly bituminizing even the softer aggregate by coating with asphalt during the process of construction tends to protect it from weathering and abrasion under traffic. If properly constructed, the surface of the tread is also protected by a bituminous seal coat. Serious consideration should, therefore, be given before otherwise suitable aggregate is rejected because it does not conform with usually recognized standards as to quality or hardness. Low cost road work necessitates every possible economy in selection of aggregates, as well as in selection of type. Softer aggregates require the maximum quantity of emulsion shown in Table 1. Rounded materials also require more binder than angular materials because they do not bond and lock together as readily.

Emulsified Asphalt.—Two types of emulsified asphalt are required for retread construction work. The first application on the coarse aggregate necessitates the use of an emulsion which is sufficiently slow-setting to permit of mixing and coating before the asphalt coalesces. This mixing emulsion may also be used in a diluted form for tack coat or priming.

The first and second penetration applications require the use of a quick-setting emulsion, of a viscosity which will insure proper penetration and coating.

Emulsions differ widely in their characteristics and in order to secure proper results it is always necessary that an emulsion be selected which has suitable properties for the work in hand. In order to be certain of good construction, emulsions for use in retread work should meet the following requirements:

	Slow-setting Mixing Emulsion	Quick-Setting Penetration Emulsion
Specific Gravity 25°/25°C. (77°/77°F.) Not less than	1.00	1.00
Viscosity—Saybolt Furol 60 cc. at 25°C (77°F.) Not more than	100 sec.	100 sec.
Miscibility—Separation 2 hrs.	None	No requirement
Coating—Separation ASTM Coating Test	None	Coating undesirable
Residue at 163°C. (325°F.) 3 hrs. 200 gms. Not less than	55 per cent	55 per cent
Demulsibility — 50 cc. N/10 $CaCl_2$ Not more than	20 per cent	....
Demulsibility — 35 cc. N/50 $CaCl_2$ Not less than	....	60 per cent
Distillation by Weight:		
Oil distillate to 260°C. (500°F.) Not more than	2 per cent	2 per cent
Residue at 260°C. (500°F.) Not less than	55 per cent	55 per cent
Penetration Residue at 25°C. (77°F.)	100 to 200	100 to 200
Solubility in carbon disulphide Not less than	98 per cent	98 per cent
Ash—Not more than	1.5 per cent	1.5 per cent

Note: Methods of Testing are not included in this discussion, but are available on application to the American Road Builders' Association.

The construction operations as outlined in Section III of the committee's report could be followed without change where emulsified asphalt is used as a binder. However, due to the extreme fluidity of emulsion and its tendency toward ready coating of stone, modifications in construction methods are recommended which will lower initial cost, improve the riding qualities and texture of the pavement—at the same time increase its density and imperviousness to water.

With emulsified asphalt the stages of construction are usually as follows:

1. Prepare foundation.
2. Apply prime coat (if needed).
3. Spread and level coarse aggregate.
4. Apply coat of asphaltic mixing emulsion.
5. Mix, by turning stone *once* or *twice* with suitable equipment.
6. Shape aggregate to proper cross-section.
7. Roll lightly.
8. Spread key-stone and broom-drag to secure uniform distribution.
9. Roll and broom.
10. Apply quick-setting penetration asphaltic emulsion.
11. Spread stone chips; broom-drag and roll.
12. Apply final application quick-setting asphaltic emulsion.
13. Spread fine stone chips, or coarse sand.
14. Roll to finished surface.

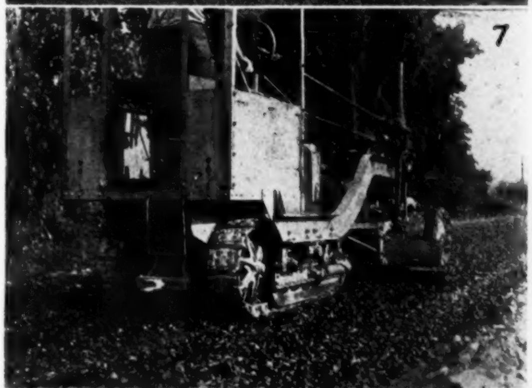
In comparing this schedule of operations with the one contained in the committee's report, it will be found that the method here described includes only one mixing application and two penetration applications of emulsified asphalt. The use of two mixing applications and one penetration application, as recommended by the committee for tars and cut-backs, has been followed using emulsion as the binder, but appreciably better results are obtained by substituting for the second mixing coat an application of penetration emulsion. The elimination of the second mixing operation effects an appreciable saving in cost and in time, while even better coverage of aggregate is secured by the additional penetration application. The use of two sizes of cover stone—one designated as "key-stone" and the other as "stone chips," is distinctly advantageous, tending to produce a more tightly keyed and bound waterproof pavement, also to produce increased smoothness and improved riding properties.

Preparation of Foundation.—Proper patching and reconstruction of the existing base is essential if uniformly good results are to be obtained. In some instances the extreme roughness of the base necessitates scarification and the addition of fresh material prior to the construction of the retread. The surface is then compacted under traffic and rolling, using water as may be required.

After consolidation is thus secured, the road is primed or tack-coated. Emulsified asphalt of the type used in the mixing operation is perfectly adapted to use in the preparation of cold patch material for leveling depressions and irregularities. In some cases the cross-section of the road has been corrected to the extent of placing a pre-mix, or road mix, leveling course, prior to the construction of the retread wearing surface.

Primer.—After the base is properly consolidated, if previously untreated, it should be given a tack-coat, or an application of suitable priming material. If the base is sufficiently well compacted to permit of brooming until a clean surface can be produced, a very satisfactory tack-coat will consist of ¼ gal. per sq. yd. of the quick-setting penetration emulsion, or of the mixing emulsion if the penetration emulsion is not yet available on the work. If the base is dry, dusty and more or less unstable, the prime-coat would preferably consist of emulsified asphalt primer, applied at the rate of about 1/3 gal. per sq. yd., or of mixing emulsion diluted with 3 to 5 parts of water and applied in such quantity as to provide 1/3 to ¼ gal. per sq. yd. of the emulsified asphalt. The primer and the subsequent applications


6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of emulsified asphalt for mixing and penetration, are all applied cold, with ordinary pressure distributors.

Spreading Aggregate.—Again, reference is made to the committee's report for a full discussion of proper methods and equipment. Whether dumped from a truck or through box-spreaders leveling with a blade-grader or drag will distribute the aggregate with sufficient uniformity for the first application of asphaltic mixing emulsion. (Illustration number 1 shows spreading 100 lb. per sq. yd. of limestone, 1½ to ½ in. on a 16.5 mile project in West Virginia. Number 2 shows leveling of coarse stone.) In dry weather, or with highly absorbent aggregate, it is desirable to apply water immediately prior to the first application of bituminous material.

First Application of Emulsion and Mixing.—The application of mixing emulsion is made cold, with any suitable distributor, (Illustration number 3 shows spreading ½ gal. per sq. yd., mixing emulsion on coarse stone) in the quantity indicated in Table I, and immediately after the application, mixing should begin. The mixing operation with emulsified asphalt is a very simple one and may be accomplished with spring-tooth harrows and disc cultivator (Illustration number 4 shows mixing coarse stone and emulsion with spring tooth harrow and disc cultivator. Two or three trips with this simple equipment were sufficient to produce satisfactory coating), or with a blade drag or maintenance machine (mixing 160 lb. per sq. yd. of coarse aggregate and ½ gal. per sq. yd. of emulsion with a maintainer. One trip with maintainer accomplished satisfactory mixing where base was uniform. Two trips sufficient in all cases. Additional mixing undesirable.) Two or three turnings of the aggregate are sufficient. Longer mixing does not improve results and tends to increase cost.

Leveling, Rolling and Keying.—After the material has received its coating of mixing emulsion, it should be leveled with a suitable drag or blade (Illustration number 7 shows leveling and shaping coarse aggregate after mixing) to the desired cross-section. The surface should then be rolled once over to prepare for the key-stone. (Illustration No. 8 shows coarse stone after coating. Note open texture which permits of keying.) Following the spreading of the key-stone in the quantity indicated in the Table of Materials, the entire surface should be drag-broomed and rolled until firmly compacted. These operations are illustrated in 9 which shows distributing key-stone on mixed base; and 6 which shows brooming keystone to secure uniform distribution and smooth riding qualities. No. 10 shows rolling keystone. The dragging shown in illustration 8 is continued throughout this rolling operation. Excessive rolling at this stage undesirable if stone crushes readily. With soft stone an application of water following this rolling tends to remove dust and insure proper coating of asphalt. The amount of rolling, as is pointed out by the committee, must be varied according to the hardness of the aggregate.

First Application of Quick-Setting Penetration Emulsion.—After the key-stone has been rolled and broomed until uniformly

TABLE I.—TABLE OF
(Quantities are

(Compacted) Finished Thickness (Inches)	Coarse Rock Size	Coarse Rock Lb.	First Appl. Mixing Bitumuls (Gal.)	Keyrock* ¾ in. to ¼ in. (Lb.)	Second Appl. Pen. Bitumuls (Gal.)
2½	2½" to ½"	200 to 210	0.6 to 0.8	25 to 30	0.5 to 0.7
2	2" to ½"	140 to 160	0.5 to 0.7	20 to 25	0.5 to 0.7
1½	1½" to ½"	110 to 125	0.4 to 0.5	15 to 20	0.5 to 0.6
1¼	1" to ½"	100 to 115	0.4 to 0.5	10 to 20	0.4 to 0.5

(Assumed weight of aggregate 2,550 lb. per cu. yd.)

*Sizes indicated refer to standard A. S. T. M. circular opening screens and 10 mesh sieves. Not more than 10 per cent of the material shall be either coarser or finer than maximum and minimum sizes indicated.

compacted, the first application of quick-setting penetration emulsion is made (See illustration number 11 showing spreading first application quick-setting emulsion (cold), at rate of .4 gal. per sq. yd. This application coats keystone with asphalt and also penetrates and coats freshly fractured surfaces in base stone. Note over-lap of spread. No damage results from this because of fluidity of emulsion which penetrates to the foundation and is spread in a thin layer underneath the pavement) at the rate indicated in the Table of Materials. This application of emulsion coats the freshly applied key-stone and due to its fluidity, also penetrates and coats newly fractured surfaces in the coarse aggregate and tends to build up the thickness of coating and bond where required to add to the strength of the pavement.

This first application of penetration emulsion is then followed with a cover of clean stone chips, of the size and quantity shown in the Table of Materials, and the brooming and rolling operation repeated. (See illustrations 12 and 13. No. 12 shows spreading 15 lb. per sq. yd. of stone chips, ½ in. to 8 mesh to fill interstices in keystone. No. 13 shows rolling first application of stone chips.)

Second Application Quick-Setting Emulsion.—The surface is then ready for the final application of penetration emulsion which serves to coat previously applied metal and to act as a seal coat for the pavement. This last application of quick-setting emulsion is followed with a cover of fine stone chips, or coarse sand, which is broomed and rolled and then opened to traffic. (See illustrations 6, 14, 15 and 16. No. 6 shows brooming stone chips to secure uniform distribution. These drag brooms insure smoothness of riding surface and uniformity of texture. No. 14 shows close-up of texture of stone chips after rolling and brooming. Pavement now ready for final application of quick-setting penetration emulsion. No. 15 shows final application quick-setting penetration emulsion applied cold. No. 16 shows spreading final cover coat ½ in. to ⅛ in. stone chips at rate of 12 lb. per sq. yd. Pea gravel or very coarse sand sometimes substituted for the last cover of chips.) The surface so constructed is uniform in texture and resists leakage. Due to the thinness of coating on the stone particles, the uniform distribution of the asphalt and the absence of any solvents which tend to soften the asphalt, the surface so constructed may be expected to give long wear without bleeding or displacing under traffic. (See illustrations 17, 18, 19 and 20. No. 17 shows drag-brooming and rolling final cover coat of stone chips. No. 18 shows final rolling of finished retread surface. No. 19 shows finished surface of West Virginia state highway project, 16.5 miles in length. Note non-skid texture. No. 20 shows close-up showing texture of Fortune Lake Park, Michigan retread. Notice non-skid surface, yet pavement is dense and waterproof.)

Broom-Drag.—In the foregoing description of construction methods reference is frequently made to the use of broom-drag. This very interesting and extremely useful piece of equipment is shown in Fig. 21, and is believed to be almost indispensable if

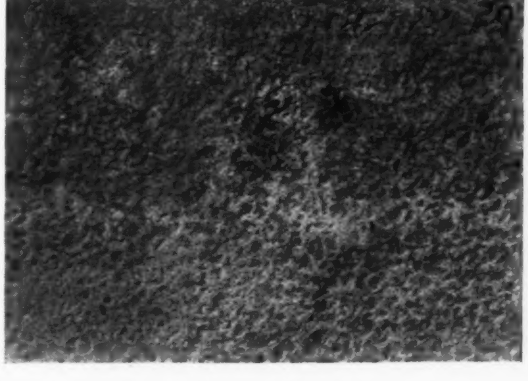
ROAD MATERIALS

per Sq. Yd.)

Rock Chips* ⅜ in. to 10 Mesh (Lb.)	Third Appl. Pen. Bitumuls (Gal.)	Sand or Rock Chips* ⅜ in. to 10 Mesh (Lb.)	Total Rock Lb.	Total Rock Cu. Yd.	Total Bitumuls (Gal.)
12 to 18	0.4 to 0.6	8 to 12	245 to 260	.096 to .102	1.9 to 2.1
12 to 18	0.4 to 0.6	8 to 12	190 to 210	.075 to .083	1.7 to 1.9
12 to 18	0.4 to 0.6	8 to 12	145 to 170	.057 to .067	1.4 to 1.6
10 to 15	0.3 to 0.5	8 to 12	125 to 150	.049 to .059	1.2 to 1.5

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

18



uniformity and riding qualities are to be secured in the finished pavement.

Retread With Pre-Coated Base.—In many instances it has been found economical to pre-coat the coarse base aggregate at the source of production, prior to being transported to the work. In such cases the coated aggregate is spread, as with the uncoated, but is immediately leveled and shaped to the required cross-section. Road manipulation of this coarse aggregate is thereby reduced to the minimum and after rolling, construction proceeds exactly as above described, including the key-stone and two penetration applications. The mixing of the aggregate at the quarry, or pit, may be economically accomplished in either a pug or drum mixer.

Fig. 21—Close-up of useful broom-drag

RECOMMENDATIONS

Several features should be given special attention when emulsified asphalts are used.

1. Over-mixing of coarse aggregate and mixing emulsion is undesirable, and if carried to an extreme is detrimental.
2. Mixing should, if possible, be carried on immediately after the application of the mixing emulsion. If conditions prevent immediate mixing, then the mixing operation should be delayed or discontinued at the first indication of stripping. Stripping indicates partial coalescence of the asphalt in the emulsion and the material should not be manipulated while this process is under way. Under ordinary climatic conditions mixing may be resumed in a few hours, at which time it will be found that the asphalt has adhered to the stone.
3. Excessive rolling of the key-stone should be avoided, particularly where soft material is being used, as this tends to produce dust and to prevent proper penetration of the two subsequent applications of quick-setting emulsion.
4. Coarser key-stone and stone chips may be used when the stone is soft, depending upon rolling to reduce the size and to insure a dense pavement.
5. Some engineers have reported better results particularly with dusty stone, when water is applied following the rolling of the key-stone. This tends to remove dust from the key-stone and to insure full penetration of the following applications.

Advice of Experience to Uncertainty

(A Letter to the editor)

PROFESSORS here are too busy teaching old stuff to investigate the new.

I read not long ago that after Harvey announced his discovery that the heart pumps the blood through the body, probably not a single physician past the 45-year mark ever accepted the new doctrine. That was two centuries ago, but we are just as dumb today, taken as a whole, when it comes to adopting new theories. Is anything the matter with our schools and colleges? Yes, everything must be pretty bad about our teaching when it remains true that our teachers are usually 20 years behind the times. God help us if we were without scientific and technical periodicals. They at least serve to bring us up to date in about 10 per cent of our activities and ways of thinking. Why not a 100 per cent? Only a few of us read their articles, and we read only a few of them. Whose fault? That of our teachers in part, and that of a million years of ancestral inheritance that leads us to eschew reading and study. But we are on our way—our painfully slow crawl upward.

In the meantime—Repeat—REPEAT—REPEAT any new, worthwhile fact or theory until it becomes remembered by most readers.

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

And We Think Our Road Tax Is High

Car owners in England pay a tax on their cars of $4.86 a horsepower. On a 29-horsepower car Germany collects about $300. Belgium is about as bad. France on a 20-horsepower car levies $87 plus a 12 per cent sales tax and a 1.5 per cent turn-over tax on the sales price. Brazil collects $50 tax on all cars. Argentina on a two-ton car gets $265. This discloses the real reason for the so-called "European type car" which has to be made with a little engine and light load to avoid the heavy taxes.—*Motor.*

On Wisconsin's System

On the Waupaca-Green Bay Road in Waupaca County. The 20-Ft. Concrete Pavement Was Laid by Paul C. Kronk, Milwaukee, Wis.

ART of the *PROSAIC*

BALLY BRIDGE
By R. Chakravarty

BALLY BRIDGE, as shown herewith, is an expression of art in wood cut by Mr. Ramendra Nath Chakravarty, Head Master, Government School of Art in Calcutta, India. The picture was taken from the Calcutta Municipal Gazette.

We need only half close our eyes to appreciate the charming effect of the whole composition. It brings out in bold, clear and most vigorous way the gigantic engineering skill and effort underlying a huge construction work. The lines and composition are simple, but bold and decisive, and the entire construction with its huge piles, piers, and cranes seem to be boldly silhouetted against a sky tearing itself in rage. The background is wonderfully designed and contrasted, and seems more like bold and swift brushwork than of wood-engraving—it is so neatly and delicately chiseled!

CONCERTED ACTION MANDATORY

Road Work Real Basis for Appropriating

Money appropriated by Congress for unemployment relief can be put to work more readily in road building than in any other way, and at the same time give the widest distribution to the funds

FEDERAL aid highway bills and emergency highway bills now pending before Congress need prompt support. Uninformed observers, it appears, seem to think that the amount of money being spent on the nation's highways is out of line with actual needs, hence there is a tendency on the part of those who do not understand roadbuilding and highway transportation requirements to cripple highway work.

The value of highway construction as a measure of unemployment relief provides a real basis for consideration of federal emergency highway funds at this time.

The size of the nation's current and future highway program depends to a very large degree upon federal leadership. States, cities, and counties acting on the urge to hold construction budgets at a high level during the last two years have strained their resources. Now mounting taxes are bringing demands upon them to curtail improvement programs and to exercise the utmost economy. Since the emergency is by no means past this is no time for a slowing up. Should the federal government refuse an emergency appropriation, thereby reducing its contribution for highways below that of last year, the example set will be far reaching in its effect. Similar reductions by states, cities and counties will likely follow so that not only those persons recently added to the pay rolls of highway organizations need be released to join the unemployed again, but men whom the highway industry to this date has afforded gainful employment as their life work will be added to the ranks of the unemployed. A real responsibility rests upon highway leaders to carry on. Truly Congress controls the "throttle" of the entire highway improvement program of the nation.

Following are a few of the reasons why federal aid highway programs should continue:

1. Out of every $1,000 spent for improving highways, $910 ultimately finds its way to the wage earner.
2. Reduction of appropriations will do more damage than good by adding to the unemployed. Reduction will be felt directly in the factory, quarry, pit, and mine.
3. $250,000,000 in highway work will have the effect of $4,250,000,000 in general business transactions annually.
4. Federal appropriation increases for emergency work spent on highway improvement lessens the amount that communities must raise for direct relief.
5. Highway construction organizations can be quickly and easily expanded because they lend themselves to employment of persons previously employed in varied activities without their having had previous training in highway construction. They can be assigned tasks that will not impose drudgery upon them.
6. Grade crossing plans are ready and their elimination is certainly uncontested.
7. Highways are far from overproduced as the metropolitan daily newspapers have been endeavoring to promote. The necessity for them is unquestioned outside of our large cities. A couple figures will show you this in short order.

   Total highway mileage—Approximately 3,100,000.
   Total surfaced and improved—Approximately 663,000.
   Per cent of total improved—Approximately 20 per cent.
8. Highway departments of states and counties, as well as federal are trained and plans are ready.
9. Considering the question from the pure dollars and cents point of view you know from experience that improved highways are less expensive over which to operate continually than are unimproved. Experimental work, the records of which I can produce, show that it costs $1.47 to operate an average car over an unimproved or non-surfaced road when it costs $1.00 to operate the same car over a high type surfacing. Do not mistake my inference here. I mention this simply to show that unimproved roads cost the motor vehicle operator half again as much in operating costs as does a good road. These same experiments show that low cost treated road surfaces cost $1.20 where high types cost $1.00 for relative operating costs. Were we to improve our entire mileage with low cost surfaces we could justify the expenditure and motor vehicle operators would save

to INCREASE FEDERAL AID FUNDS

Emergency Funds for Unemployment Relief

enough in five years' time over previous operating costs to pay for the entire improvement. We easily prove this by capitalizing the annual saving at 4 per cent for 5 years.

10. The annual operating expense of our approximately 26,500,000 motor vehicles is about $20,000,000,000. In the last paragraph I stated improved roads save 27 per cent. Let us be conservative and say only 20 per cent. Twenty per cent of $20,000,000,000 is $4,000,000,000. This would be an annual saving of approximately $151 per vehicle. This means something to your constituency.
11. Highways can be built now for prices less than at any previous time. Following is what Mr. C. M. Babcock, Commissioner of Highways in Minnesota, has to say:

"It was good business for Minnesota to expand its highway construction program in 1931, to judge by figures given out by C. M. Babcock, commissioner of highways. Unit prices on every class of construction were substantially lower than in 1930 and previous years. Average prices on some of the principal items were as follows:

	1930	1931
Paving, except cement, per sq. yd.	$ 1.302	$ 1.252
Cement for paving, per sq. yd.	.622	.466
Net per sq. yd., slab only	1.924	1.718
Grading excavation per cu. yd., including overhaul	.296	.2486
Bridges, per lineal foot	181.70	160.28
Gravel surfacing, per cu. yd.	1.003	.837

The average cost per mile of concrete paving, 20 feet wide, dropped from $25,508 in 1930 to $22,920 in 1931. This includes shouldering, curbs, drains and all miscellaneous items.

The average cost of grading dropped from $10,621 per mile in 1930 to $8,608 in 1931. When right-of-way, culverts, bridges and miscellaneous structures are included, the average per mile was $17,396 in 1930 and $14,972 in 1931.

The drop in gravel costs is greater than the cost per yard would indicate, since the average haul increased from 4.22 miles in 1930 to 4.78 miles in 1931. The average cost per mile dropped from $1,602 in 1930 to $757 in 1931, partly due to lower prices and partly to a decrease from 1,598 cubic yards per mile in 1930 to an average application of 904 cubic yards on roads graveled in 1931. Less gravel is used because paving or bituminous treatment now follows closer after the grading and graveling.

The average cost per mile of new bituminous treatment dropped from $1,590 in 1930 to $1,307 in 1931, and the average cost of retreatments from $793 in 1930 to $761 in 1931.

Improved machinery, keen competition between material producers, buying in larger quantities, and general business conditions combined to bring prices down, Mr. Babcock said. When business conditions return to normal, there may be some increase in prices, but more efficient machinery will probably keep costs down below the unit prices of 1930 and preceding years. We are not only getting needed improvements at low prices, but road work is furnishing employment to thousands of people who need it he said. Investing money in good roads now will bring dividends for many decades.

12. Improved highways are an investment that produce actual returns in the form of savings to operation of motor vehicles.

In view of the urgent need for more improved roads, the cash benefits received, the employment received, the employment of three-quarters of a million men on state and local roads, road building this year and in years to come should maintain its pace.

No cog in the wheel should be hack-sawed. Money dedicated by motorists through gasoline and motor vehicle taxes to the cause of good roads should be used for good roads. Every state should fight gasoline tax evasion, which is costing us upwards of $40,000,000 a year. Federal participation should continue in full measure. States must meet this federal challenge.

It is urgent that senators and congressmen of every state learn from their constituents the true picture of conditions "at home" and the sentiment prevailing for federal action. You know circumstances within your area. You possibly have contacts which extend beyond the limits of your own state. We recommend that you review circumstances within the industry as you know them and immediately take such action as you deem appropriate to impress upon your congressional delegation the urgency of favorable action as to regular federal aid and such emergency measures as may be helpful in meeting the present situation.

We suggest endorsement of legislation, first to continue federal aid, and secondly, to appropriate emergency funds for highway improvement as a measure of relief for unemployment. Action by Congress is likely at an early date. Convey your support by telegram or letter without delay.

Simplicity, Harmony, Proportion

Beauty in Bridge Work

BEAUTIFUL BRIDGES, an imposing series of them, will mark the new State highway now in course of construction along the rugged coast between Carmel and San Simeon. One of the most scenic portions of the Pacific shoreline, this section is indented by arms of the sea and furrowed by deep gorges through which mountain streams reach the ocean making bridges necessary for a direct highway route. Five of them are required in a distance of thirty miles. Two of these are the Garrapata Creek Bridge shown at the top, a 285-foot structure, sixteen miles south of Carmel, completed and opened to traffic and the Granite Creek Bridge, eleven miles south of Carmel and 288 feet long, shown in the lower picture, which is just about finished.

Courtesy California Highways and Public Works

Interpretation OF TESTS ON *BITUMINOUS ROAD MATERIALS*

By RICHARD H. LEWIS
Associate Chemist, U. S. Bureau of Public Roads

The purpose of this article is to acquaint engineers and inspectors with the reason for making tests on bituminous materials and what is the practical significance of the various tests. It will be run in two parts. The discussion on tars and emulsions will appear next month.—Editor.

WITHIN the past few years the use of bituminous materials has been greatly stimulated by the construction of intermediate and low-cost roads in all sections of the country. In most states, some type of bituminous material is being employed in combination with the available supply of mineral aggregate to build roads which will adequately take care of the traffic requirements of the various communities.

This increased use of bituminous materials has been accompanied by a desire on the part of many highway engineers, who have previously been unfamiliar with bituminous construction and maintenance, to know something of the nature of the asphalt, road oils, tars and bituminous emulsions which they are called upon to use and the tests around which the specifications for the materials are drawn.

Bituminous materials of interest in road work are tars and asphalts which either occur in nature or are obtained by refining certain types of petroleum such as are found in our middle western states, California, Mexico and Columbia.

Tars.—Tars derived, in case of coal-gas tar and coke-oven tar, from the destructive distillation of coal, and water-gas tar produced from the decomposition of petroleum used to enrich water-gas, are further refined and combined to make all grades of road tars from thin fluid priming material to heavy tar pitches used in filling cracks.

Asphalts.—Since native asphalts after refining are much too hard for use, the refined asphalt is softened by adding a suitable flux to secure the desired consistency for the particular construction in which it is to be used. Asphalts produced from petroleum, called oil asphalts, are usually obtained by subjecting the petroleum to a steam distillation which process accelerates the distillation and prevents the residue from being decomposed by local overheating.

Road oils of various degrees of fluidity or consistency and different degrees of adhesiveness are produced from crude petroleums. The refiner may also make up road oils by blending various oils and otherwise modifying his process to get the proper grade of material; or by fluxing semi-solid or viscous fluid asphaltic materials with certain distillates such as naphtha and kerosene to produce so-called cut-backs. An incident relating to the inception of the use of cut-backs is of interest in this connection. Much of the early surface treatment of macadam roads was done with crude asphaltic petroleums. This material, in many cases, did not dry fast enough or develop sufficient hardness to hold the cover stone. A few years ago one of the leading asphalt producers was asked to furnish a product made up of an asphalt fluxed with a volatile solvent. The idea was then considered ridiculous by the producer, but it is quite reasonable to say that, at the present time, practically all the cold surface treatment materials designed for mat-forming treatments are naphtha cut-backs.

Bituminous emulsions are suspensions of bitumen in water. They are extremely fluid and can be applied without heating. While both tar and asphalt can be emulsified, the bituminous emulsions used in this country are, in most cases, asphaltic emulsions. These emulsions, depending on their fluidity and their time of break, have many uses in road construction and maintenance.

While the chemical composition of the various bituminous products is of interest to the chemist, and while the work of Richardson and others has indicated the necessity for further research along purely chemical lines, it is nevertheless true that the tests which control the specifications for the many bituminous road materials are physical tests. Mainly empirical, these tests have been gradually standardized as to method and equipment so that in the United States, at least, they have a definite procedure and can within certain limits be expected to demonstrate particular qualities inherent in the materials and their suitability or unsuitability for particular types of highway construction.

SEMI-SOLID ASPHALTS

In the construction of the higher type bituminous pavements, such as sheet asphalt and bituminous concrete, the harder asphalts are utilized. In penetration macadam, the softer asphalts, viscous tars and asphaltic emulsions have all been employed as binding materials. The tests controlling various specifications for asphalts will be first briefly discussed.

ASPHALT SPECIFICATIONS.—Asphalts are usually described by specifications so that the particular type and grade desired by the user can be properly identified. The types which are most generally specified are petroleum or oil asphalt, Bermudez asphalt and Trinidad asphalt. The grades in greatest demand and usually stocked by producers are identified by penetration and are 120-150, 100-120, 85-100, 60-70, 50-60, 40-50.

The higher the penetration, the softer the asphalt. The three higher penetrations are generally used in penetration macadam, the choice being dependent usually on climatic and traffic conditions. The lower penetration materials form the bituminous binders in bituminous concrete and sheet asphalt construction. Typical specifications covering the various types in a grade suitable for graded bituminous concrete in southern United States or northern United States, under heavy traffic or for sheet asphalt in northern United States under light or moderate traffic are given in Table 1. Typical analyses of materials meeting these specifications are shown in Table 2.

Specific Gravity.—The specific gravity of an asphalt when considered in connection with the consistency of the material is of value in identifying the type. If the petroleum asphalts are derived from the same base petroleum the higher the specific gravity, the lower the penetration. It is quite indicative of the uniformity of the products supplied from a given source. In examining a series of samples of material to be used on a large construction job, the agreement in the specific gravity values was found to be surprisingly close. The grade of material was 50-60 penetration. Seventy samples showed a specific gravity range of 1.019 to 1.026. Three samples were over the penetration limit of 60 with specific gravities of 1.019 and 1.020 so that 67 tank cars of this material showed a small density range of .006. The determination is not only a valuable identification test, but it is also useful in making calculations needed for proper control of proportions in bituminous construction. Purchases are made on both a volume and weight basis, and the gravity is important in changing from weight units to volume units, or from volume units to weight units. Specific gravities at two different temperatures make it possible to determine the coefficient of expansion of the asphalt, which is a necessary factor in computing tank car measurements.

In order to compare the bitumen content of various bituminous aggregates, the specific gravity of the asphalt as well as the density of the mineral aggregate must be considered. To accurately determine whether the pavement has received the desired compression under the roller, the specific gravity value of both the bitumen and aggregate must first be determined in order to compute the maximum possible density of the mixture and in turn the per cent of voids in the compressed pavement.

Flash Point.—The flash point values of asphalts are generally considerably above the minimum requirements given in Table 1, except in the case of the fluxed native asphalts. Lower refining temperatures and the presence of readily volatile matter in the flux are responsible for lower flash point values for fluxed native asphalts. For a given type and grade of asphalt the flash point will vary within narrow limits. Asphalts are seldom heated over 325° F. (163° C.) in paving plants and the fire hazard is very low.

Softening Point.—The determination of the softening point of asphalts is purely an attempt to record the temperature at which the material freely flows. Asphalts being a mixture of many different chemical compounds have no definite melting point. The standard method for determining the softening point of asphalt is the ring and ball method. Of two asphalts having the same penetration, the one with the lower softening point generally is more susceptible to temperature change. Asphalts produced by blowing air through residual petroleums have, for the same penetration, much higher softening points than steam distilled asphalts, and are therefore less susceptible to temperature change.

The volume of traffic and climatic conditions are important factors to consider in designating the penetration of the asphalt suitable for a particular construction. For the same method of construction softer grades of asphalts are generally selected for pavements in northern sections than those that are preferred in southern sections. Heavy traffic roads require the harder grades; and pavements which serve only a moderate amount of travel are best constructed with the softer grades of asphalt.

Penetration.—The susceptibility of asphalts to temperature change may, perhaps, be better shown by the penetration values at various temperatures. The normal penetration temperature is 77° F. (25° C.), the weight of the needle 100 grams and the time 5 seconds. The other two temperatures used are 46.1° C. (115° F.), the load being changed to 50 grams and the time remaining 5 seconds and 0° C. (32° F.) with a load of 200 grams for 60 seconds. As a general rule, asphalts designed for use as fillers are only tested at these three temperatures. However, information of great value to highway engineers could, no doubt, be obtained if the asphalts used in the higher types of construction were tested in the same way, or in some manner to definitely bring out the effect of temperature on asphalts which have the same consistency at normal temperature 77° F. (25° C.).

A study of Tables 3 and 4 will show some very interesting relationships. In Table 4 the load and time are constant for the three temperatures.

TABLE NO. 1.—TYPICAL ASPHALT SPECIFICATIONS

Material	Petroleum or Oil Asphalt AP-6-25	Bermudez Asphalt AB-6-25	Trinidad Asphalt AT-6-25
1. Specific gravity, 25°/25°C (77°/77°F.)	Not less than 1.010	1.050—1.070	1.200—1.250
2. Flash point not less than	175°C. (347°F.)	175°C. (347°F.)	175°C. (347°F.)
3. Softening point	40°C.—60°C. 104°F.—140°F.	45°C.—55°C. 113°F.—131°F.	45°C.—55°C. 113°F.—131°F.
4. Penetration at 25°C (77°F.) not less than	50—60	50—60	50—60
5. Ductility at 25°C. (77°F.) not less than	40 cms.	40 cms.	40 cms.
6. Loss at 163°C. (325°F.), 5 hrs., not more than	1.0	3.0	3.0
(a) Penetration of residue at 25°C., 100 gms., 5 sec., as compared to penetration before heating, not less than	60%	50%	50%
7. Bitumen soluble in CS_2, not less than	99.5%	94.0%	68.0%
(a) Organic matter insoluble	.02%		
(b) Inorganic matter insoluble, not more than		2.5—4.0%	20.0—30.0%

In order to secure a uniform product for a given contract, the following requirements, type and grade, a provision that the material shall not vary more than 10°C. in softening point from the test limits specified in the above table nor more than .020 in specific gravity where no maximum limit is specified, are often made a part of the specification.

TABLE No. 2—ANALYSES OF TYPICAL ASPHALTS

	Petroleum or oil asphalts				Fluxed native asphalts	
	Mexican	California	Columbia	Blended	Bermudez	Trinidad
Specific gravity, 25°/25°C.	1.045	1.018	1.025	1.016	1.068	1.248
Flash point, Cleve. open cup (°C.)	249	277	315	263	185	207
Softening point, ring and ball (°C.)	55	46	52	59	51	56
Penetration at 25°C.	53	59	57	53	60	59
Ductility at 25°C. (cms.)	110+	110+	110+	59.5	42.4	40.5
Loss 163°C., 5 hrs. 50 gms. (%)	0.05	0.15	0.04	0.19	1.23	0.46
(a) Penetration of residue at 25°C.	41	42	49	49	43	43
(b) Original penetration (%)	77.3	71.2	86.0	92.4	70.2	72.8
Bitumen soluble in CS_2 (%)	99.89	99.83	99.86	99.88	94.74	69.09
Organic matter insoluble (%)	0.09	0.09	0.12	0.12	2.07	4.40
Inorganic matter insoluble (%)	0.04	0.08	0.02		3.17	26.51
Proportion bitumen insoluble in 86°B. naphtha (%)	30.43	10.69		28.13	25.18	31.13
Fixed carbon (%)	16.22	8.78		13.12	14.16	11.18

TABLE No. 3.—EFFECT OF VARIATIONS IN TEMPERATURES ON PENETRATIONS OF ASPHALTS WITH VARIABLE LOAD AND TIME

Temperature Deg. C.	Load grams	Time sec.	California asphalt pen.	Mexican asphalt pen.	Blended asphalt pen.	Blown asphalt pen.
0	200	60	3	13	22	27
0	200	5	2	8	12	19
0	100	5	1	4	6	8
25	100	5	46	49	60	44
25	50	5	32	32	40	26
25	100	1	25	26	35	36
46	50	1	180	116	121	54
46	50	5	340	227	220	70
46 (a)	100	5	503	338	328	104

(a) Assuming that the same relation would hold between 50-gram and 100-gram loadings as has been found to exist for various penetrations of same material made at normal temperature. Factor used for California 1.48; for the Mexican and blended 1.49; for the blown 1.63.

TABLE No. 4—PENETRATIONS AT THREE TEMPERATURES; TIME 5 SECONDS, LOAD 100 GRAMS

Temp.	California asphalt	Mexican asphalt	Blended asphalt	Blown asphalt
0°C.	1	4	6	8
25°C.	46	49	60	44
46°C. (1)	503	338	328	104

(1) As in Table 3, values are calculated.

It will be readily seen that California asphalt shows the greatest susceptibility to temperature changes as measured by the penetration at the three temperatures. The penetration at 25° C. is 46 times greater than at 0° C., and the penetration at 46° C. is 12.4 times the penetration at 25° C. For the Mexican asphalt the 25° C. penetration is 12.25 times 0° C. penetration, and at 46° C. it is 6.9 times the value of 25° C. For the blended, the 25° C. penetration is 10 times the 0° C., and the 46° C. is 5.4 times the 25° C. penetration. The behavior of the blown asphalt clearly shows why this material is particularly desirable for use alone as a filler. It has a very low susceptibility, the penetration at 46° C. being just 13 times the penetration at 0° C. or about the same relationship as exists between the 0° C. and 25° C. penetrations for Mexican asphalt and between the 25° C. and 46° C. penetrations for the California asphalt.

The importance of the susceptibility of various asphalt to temperature changes has not been thoroughly appreciated by highway engineers. The effect of too soft an asphalt in a pavement is somewhat similar to that caused by too much asphalt. Some years ago the Bureau of Public Roads built a number of test sections of sheet asphalt and bituminous concrete, among which were the following variables. The consistencies, as measured by the penetration, of the asphalts used were 45, 55, 65, 75 and 85. The amount of asphalts varied from what was obviously insufficient to what was undoubtedly an excess. These pavement sections were constructed early in the fall and immediately subjected to traffic. As long as the air temperature was below 65° F. there was no effect on the surfaces. The pavement was perfectly rigid. When air temperature reached 80° F. the sections in which the softer penetration asphalt and high percentages of asphalts were used began to show evidence of shoving and rutting. The maximum pavement temperature in any of these sections was 140° F., corresponding to a maximum air temperature of approximately 100° F. The sections having high penetration asphalt as binder, and high percentage of bitumen, showed the greatest movements. With the return of colder weather all the sections again became rigid. Undoubtedly the susceptibility of asphalts to temperature change is an important factor in the road behavior of the higher type bituminous pavements, yet most specifications for oil asphalts are so written that no provision is made for securing an asphalt which has the susceptibility range best suited to the particular climate and construction.

Ductility.—The ductility requirement is not present in all specifications for asphalts. It is usually omitted for the softer grades. In this day of more careful refining technique the minimum of 40 centimeters called for in the specification of Table 1 is very liberal. Many asphalts produced from various bases have ductilities in excess of the length of the machine in which the test is run. A few laboratories have ductility machines capable of recording pulls of two hundred centimeters. The majority of the testing laboratories are limited to machines 100 centimeters in length. To properly compare the ductility value of the different grades and types, two suggestions have at various times been made. The standard temperature for making this test is 25° C. The rate of pull is 5 centimeters a minute. It has, therefore, been suggested that the temperature be lowered to a point where all the ductility values are within the range of the 100 centimeter machine. The other suggestion is that the rate of pull be increased which will cause a number of materials to break within 100 centimeters. Some specifications require that the ductility be made at 4° C. and 1.5° C. Many asphalts having high ductility at 25° C. are brittle at the low temperature. Short materials or materials of low ductility at 25° C. may retain a relatively high ductility at the lower temperature.

The ductility test has been severely criticized by some bituminous authorities and defended by others. Highly adhesive materials are very ductile, and, until such time as a satisfactory test for adhesiveness is developed, the ductility test will undoubtedly remain in the specifications. Where the pavements constructed with asphalt are subjected to exceedingly heavy traffic, a high ductility is demanded. It is also worthy of note that where climatic conditions are very moist, those engineers and chemists observing the road behavior have held that high ductility asphalt has proven most serviceable.

Volatilization Loss.—It has, at times, been contended that the volatilization test at 163° C. is too severe, and that it subjects the material under test to changes that

would not occur under ordinary conditions of exposure. This is to some extent true of semi-solid asphalts; but there are few carefully prepared asphalts, oil or native, which can not successfully meet the specification requirements for this test. Few oil asphalts will lose as much as one per cent after five hours in the 163° C. oven, and the consistency or penetration of the residue is usually well over 60 per cent of the original penetration.

If, however, an asphalt did have an excessively high loss and the penetration after heating was low, it is very probable that it would harden materially when distributed in thin films over the mineral aggregate in the mixing box at the paving plant. This would be especially true if the stone and sand were slightly overheated.

It has been definitely established that semi-solid asphalts in relatively thin layers harden in many cases without an appreciable loss of volatile matter when exposed to air and light. If a sample, prepared for the penetration test, is allowed to stand exposed to light and air in the laboratory, it will gradually become harder as measured by the penetration test, but on reheating and cooling to test temperature, returns to the original penetration. The thin hardened skin on remelting and mixing does not materially lower the penetration of the entire mass.

Asphalt, used as seal, undoubtedly does harden rapidly on continued exposure; but the examination of a large number of sheet asphalt and bituminous concrete pavements after 10 to 15 years' service, indicated that there was not a very great hardening of the asphalt in these more dense surfaces. The penetration of the extracted bitumen was generally very close to the original penetration reported when the material was used. This is in spite of the fact that the consistencies on extracted bitumens tend to run low because of the prolonged heating necessary to remove the last traces of solvent used in extracting them. The relatively large volume of mineral aggregate protects the asphalt in the mix from the light and air which so rapidly harden surface films of pure asphalts.

Solubility in CS_2.—By definition, asphalts are bitumens and are distinguished by their solubility in carbon disulphide. A carefully prepared petroleum asphalt is nearly completely soluble in carbon disulphide. The native asphalts, because of first, their origin, and second, the difficulty of removing all the organic and mineral impurities during refining are not as soluble in carbon disulphide as the petroleum asphalts. The amount of both organic and inorganic matter insoluble in carbon disulphide is kept within fairly narrow limits in fluxed native asphalts and will generally fall within the minimum and maximum values of the specification shown in Table 1.

When Trinidad asphalt is used in sheet asphalt or bituminous concrete construction, the plant proportions must be altered to adjust for the high inorganic matter which acts as a filler. The per cent of asphalt is increased and the usual amount of limestone or cement filler decreased in order to compensate for the high percentage of mineral matter present in the asphalt cement.

Before refining processes reached their present high efficiency, many oil asphalts showed a high percentage of organic insoluble in carbon disulphide. This was due to incipient cracking, and it has been considered that a high carbon disulphide insoluble, accompanied by a high insoluble in carbon tetrachloride, indicates that the material had been injured. Many specifications include a determination for carbenes (organic insoluble in carbon tetrachloride) as well as the carbon disulphide solubility, but a high organic insoluble with carbon disulphide in petroleum products, usually points to a high percentage of carbenes. Therefore, both determinations are often not included in the same specification. In some specifications the organic insoluble clause is eliminated and in its place a requirement of 99.0 or 99.5 per cent solubility in either carbon tetrachloride or carbon disulphide is substituted.

Several tests, such as the per cent of bitumen soluble in 86° naphtha, fixed carbon, and paraffin scale are not called for in most asphalt specifications. The first two are purely identification tests. Materials meeting the requirements of the usual asphalt specifications have definite percentages of both asphaltenes and fixed carbon, which are typical of the particular petroleum from which the asphalt is produced. The paraffin scale test has been the subject of much controversy; first, because of the inaccuracy involved in methods proposed for its determination; second, because the injurious effects of the so-called paraffin scale in asphalt on the road building properties of the asphalt have never been substantially proven.

Fluid Asphaltic Materials

The first employment of liquid bituminous materials began with the introduction of the automobile, when they were employed as dust palliatives to allay the dust stirred up by the faster moving rubber tired vehicles. Then came the development of the surface mat-forming treatments in which both hot and cold applications of asphaltic material were used to protect the underlying macadam from the wear and tear of traffic.

At the present time there are numerous types of low-cost road surfaces employing fluid bituminous materials of many different characteristics and degrees of consistency or fluidity. Double surface treatments, oiled earth, sand mixed-in-place, retread, oil processed, blotter treatment, oiled macadam and many other locally named surfaces are built and maintained with various grades of these fluid products.

The fluid asphaltic products are derived from crude asphaltic, semi-asphaltic and, in some rare cases, highly paraffin petroleums, topped and residual petroleums, cutback asphalts, blends of topped and residual petroleum with cracking coil residues, and cracking coil residues of a satisfactory fluidity or viscosity.

The specifications governing semi-solid asphalts are well standardized; but the specifications and tests controlling the quality, the characteristics and use of the fluid asphaltic materials are quite varied, even in neighboring states.

Nevertheless, the following laboratory tests are usually found in the majority of specifications, and, like the tests for the semi-solid asphalts, they attempt to discover the original character of the material and its probable behavior under traffic:

1. The viscosity test at 25° C., 50° C. or 100° C.
2. Loss at 163° C., or additional temperature, with consistency test on the residue.
3. The per cent of residue of a specified penetration, with a ductility test on the residue.
4. Distillation test with consistency tests, float or penetration and ductility test on the residue.

These tests, within certain limits, show the original character of the material, the amount of volatile matter it may lose, the rate of volatilization, the amount of residue after drying, and the consistency and adhesive-

ness of the residual bituminous material.

Viscosity.—The viscosity of fluid asphaltic materials may be run with either the Engler or the Saybolt Furol viscosimeter. Furol viscosity in seconds may be roughly estimated as four times the Engler specific viscosity for the same temperature. The specifications state the instrument to be used and the temperature at which the determination is to be made. The temperatures at which the viscosity is determined are often not the same for the identical materials in different states.

The temperature of applying the material on the road controls the specification temperature in one state, while the ease of making the test and the need for expediting the laboratory routine govern the selection of the test temperature in other states. At higher temperatures, the time consumed in making the determination is greatly reduced. Thus similar materials are run at 25° C. (77° F.), 40° C. (104° F.), 50° C. (122° F.) and 60° C. (140° F.) by various state laboratories. No accurate comparison of viscosities at these different temperatures can be made, since the rate of change in viscosity for change in temperature is not constant for road oils from various sources.

The following table, showing viscosities at four temperatures for certain grades of road oil, will illustrate the difficulties involved in converting values from one temperature to another when the factor for the particular product is not known.

TABLE No. 5.—EFFECT OF TEMPERATURE ON VISCOSITY

Material	Specific viscosity Engler at 25°C.	40°C.	50°C.	100°C.
California residual	80.6	24.6	14.5	*
California residual	*	94.6	41.4	3.6
Texas residual	36.0	15.0	9.0	*
California crude	82.3	29.0	16.2	
Wyoming residual	*	51.3	28.3	2.7
Wyoming residual	*	85.9	37.8	2.9
California residual	111.8	37.7	20.6	
California residual	*	137.9	65.9	4.9
Naphtha cut-back	112.0	31.0	*	*
Naphtha cut-back	*	62.0	34.0	*
Kerosene cut-back	*	167.0	79.0	*
Kerosene cut-back	*	212.0	95.0	*

*Test not run at this temperature.

The required viscosity of a material for a given purpose depends upon the character of the surface to be treated, climatic conditions and the construction equipment available. A dust palliative should be fluid enough to secure rapid penetration into the road surface without appreciable residue. In surface treatment work, the bituminous material should remain on the surface and accordingly, extremely low viscosities which permit the road oil to penetrate the road surface are avoided. In repair work, the cold patch materials can be more viscous if the mix is made by machine. If hand-mixed material and stock piled for partial hardening, the lower viscosities prove more desirable. A more fluid product is needed for road mixes than for plant mixes. A more viscous material is preferable in retread where the aggregate is of an open grading.

In hot surface treatment, the bituminous material should have sufficient body and adhesiveness to hold the cover stone immediately when placed with small or no loss of volatile so that many specifications not only include a viscosity requirement at 100° C., but also have a float test requirement on the original material. In one state the specification calls for the application of the hot surface asphalt at a temperature close to 150° C. and the specific viscosity Engler is from 12-17.5 at 150° C. Because of the character of the mineral aggregate, the low viscosity at time of application is undoubtedly a distinct advantage in this particular construction.

Volatilization Loss.—The laboratory determination of the amount of volatile matter the road oil may be expected to lose on exposure can be done in two ways. An evaporation test, loss at 163° C. for five hours, and a distillation test are both valuable for this purpose. Often specifications call for an additional volatilization test at a lower temperature as an indication of the speed of drying.

The standard A. S. T. M. method for the volatilization test calls for a 50 gram sample; but many states, while using this size sample for semi-solid asphaltic materials, have retained the old 20 gram sample for fluid materials. In reporting the loss at 163° C., the size of sample should always be stated. The material in the 20 gram container has a smaller depth and greater cross-section, and the loss and degree of hardening are much more pronounced. In the case of highly volatile cut-backs, the agreement in per cent loss is quite close, but the difference in hardness of residue is very evident. If possible, consistency tests on the residue should always be made.

TABLE No. 6.—COMPARISON OF 50 AND 20 GRAM LOSSES AT 163°C. IN VARIOUS ROAD OILS

	50 Gram sample	Consistency test on residue		20 Gram sample	Consistency test on residue	
Material	Loss per cent	Float test 50°C. seconds	Penetration 25°C.	Loss per cent	Float test 50°C. seconds	Penetration 25°C.
Mexican hot oil	0.37	136		0.77	177	
California 80-85 road oil	0.44	192		0.95	240	
Hot surface treatment oil	0.73	122		1.49	210	
90-95 road oil	2.29	202		3.84	341	
70 per cent road oil	5.65	68		9.12	116	
55 per cent road oil	11.55	16		17.65	43	
No. 5 road oil	10.90	20		19.20	49	
Cut-back asphalt	24.10		117	25.50		58
Cut-back asphalt	22.10		164	23.50		101
Cut-back asphalt	26.20		78	27.30		44
Cut-back asphalt	26.60		67	27.70		42

Distillation.—The distillation test by several methods has been substituted for the volatilization test in many cut-back specifications, and it has been suggested for general use for all types and grades of road oils. It gives a better picture of the material under examination than the volatilization test. Two materials may lose the same amount of volatile matter in the oven tests, but the distillation will show that in one case the distillate will come over at lower temperature than in the other case. The material with a greater per cent of distillate in the low temperature fractions should develop cementing value much sooner than where the greater proportion of distillate is in the higher temperature fractions.

A material whose residue is fluid in one test will be fluid in the other, and a semi-solid residue will be obtained from both determinations if the material under test is a rapid curing cut-back. There is considerable hardening of the residue not due to loss of volatile oils in the oven tests, and this does not take place to the same extent during a distillation. Consistency tests (float or penetration), ductility test and carbon disulphide solubility are made on residues from distillation.

Road oils suitable for surface treatment, cold patching and mixed-in-place construction, with open graded aggregates, should lose most of their volatile and develop a residue of good cementing value. Dust palliatives should have a low loss and the residue should have little binding value. Road oils used in mixed-in-place work where mineral aggregate is high in fines should show a slow drying tendency, and, where the development of cementing value is low, these roads can be successfully

machine maintained. Where cut-backs are used in mixed-in-place construction with fine or graded aggregates, the presence of considerable volatile matter in the pavement, as laid down for traffic, produces surface crusting and the hard surface cannot be successfully maintained by machine.

The per cent residue of 80 or 100 penetration for road oils appears in many specifications. The road oil is heated between temperatures of 249° C. to 260° C. until a residue of the desired penetration is obtained. While many cut-backs will come down to the required penetration with one-half hour heating, there are many materials being used in road work which require many hours heating at this high temperature to produce a residue of the consistency wanted. In one case, a mid-west residual took 42 hours heating to attain the penetration of 100.

Where the fluid material is spread so that comparatively thin films are exposed to light and air, there is unquestionably a hardening which is due to the loss of the volatile parts of the road oil; but slow and medium drying oils, which are placed either by penetration or admixture below the road surface and are protected from atmospheric action, will take many years to come to a semi-solid condition. Oils extracted from samples obtained from oil processed roads of the west and the oil earth roads of Illinois after three and four years in the road were still decidedly fluid.

If a time limit, within which a road oil should, under the conditions of the test, come to a specified consistency, is stipulated, the test might prove of great value for identification of road oils where a variable source of supply and non-uniformity of blends vitally affect the road behavior of the mixes in which these materials are used. Nevertheless, it is probable that even in this case the test is of little value in actually predicting the serviceability of a particular road oil.

Identification Tests.—Other tests appearing in many specifications are largely used as means of identification and are as follows: 1. Specific gravity. 2. Flash point. 3. Solubility in carbon disulphide. 4. Solubility in naphtha. 5. Fixed carbon. 6. Paraffin scale.

It will be seen that with the exception of the per cent of residue of a given penetration and the distillation tests, the materials are defined in about the same way as the semi-solid asphalt.

The specific gravity test on fluid asphaltic materials is not as indicative of the source of the material as is this test with the semi-solid materials. This is because blends and cut-backs may vary greatly in gravity of components. As a control test, however, for a number of shipments of the same grade of road oil, the determination is valuable.

The flash point determination has been thought by some to give an idea of the probable volatility of the light oils in a road oil. This is not always the case, since a very little of a light naphtha can lower the flash point considerably, yet the greater part of the volatile material may be of such a character that the material may prove to be exceedingly slow drying. The flash point test, however, should give the field man some idea as to what temperature the road oil can be safely heated. The flash point determination is dependent on the type of tester in which the test is made. The values for closed cup are lower than the values for open cup. In reporting the flash point temperature the instruments used for making the test should be stated.

The solubility in 86° naphtha and fixed carbon tests when run on topped or residual petroleum can be used to identify the source. Those road oils having little or no naphtha insoluble (asphaltenes) can hardly be expected to develop a great amount of adhesiveness.

The paraffin scale requirement is even of more doubtful value in a road oil specification than in an asphalt specification. The clause setting a maximum of two per cent paraffin is included in many of the far west specifications covering road oil for use in oil processing. These oils have exceedingly slow drying properties and it is improbable that the presence of paraffin scale would retard the development of any binding properties,

TABLE NO. 7—ANALYSES OF TYPICAL ROAD OILS

Name of material Material used as	45% road oil Prime	60-70 road oil Road mix	60-70 road oil Road mix	60-70 road oil Road mix	85-100 A. C. naphtha cutback Surface treatment	100-120 A. C. kerosene cutback Road mix	94+ road oil kerosene cutback Road mix
Specific gravity, 25°/25° C.	.943	.967	.966	.965	.942	.977	.967
Flash point, open cup (°C.)	91	161	141	132	30	85	84
Spec. viscosity, Engler, 25° C.	36.0						
Spec. viscosity, Engler, 40° C.	15.0		100.5	135.8	62.0		
Spec. viscosity, Engler, 50° C.	9.0	78.5	53.6	62.3	34.0	57.0	95
Loss 163° C., 5 hrs., 20 gms. (per cent)	25.13	5.01	8.11	11.37	25.9	21.8	15.9
Float test on residue, 50° C. (sec.)	30	28	37	48			
Penetration on residue, 25° C.					56	139	199
Loss 163° C., 5 hrs., 50 gms. (per cent)	15.40	3.24	6.00	6.95	25.3	16.3	12.8
Float test on residue, 50° C. (sec.)	11	26	30	27		102	
Penetration on residue, 25° C.					104		110
Soluble in carbon disulphide (per cent)	99.93	99.85	99.96	99.88	99.91	99.75	99.86
Organic matter insoluble (per cent)	0.07	0.11	0.04	0.08	0.07	0.23	0.11
Inorganic matter insoluble (per cent)	0.00	0.04	0.00	0.04	0.02	0.02	0.03
Bitumen insoluble in 86° B. naphtha (per cent)	13.30	7.50	12.60	11.30	15.52	17.51	10.05
Percentage of residue of 100 penetration	51.4	62.5	64.3	63.2	73.8	75.3	76.7
Softening point of residue (°C.)	52.4	45.8	45.2	46.3	48.4	44.0	45.7
Ductility of residue, 25° C. (cms.)	110+	110+	110+	110+	110+	110+	110+
Ductility of residue, 1.5° C. (cms.)	7.2	4.5	4.7	5.2	6.4	7.0	4.8
Simplified distillation:							
Total percentage by volume to 150° C.	0.0	0.0	0.0	0.0	1.5	0.0	0.0
Total percentage by volume to 225° C.	0.0	0.0	0.0	0.0	22.7	0.0	0.0
Total percentage by volume to 315° C.	31.5	0.0	1.3	3.5	29.8	16.9	14.7
Total percentage by volume to 360° C.	42.5	5.0	10.8	15.8	31.5	21.0	19.3
Penetration of residue, 25° C.					82		
Float test of residue, 50° C. (sec.)	133	33	42	65		236	204
Ductility of residue, 25° C. (cms.)					110+		

yet its presence in the road oil may decidedly improve the water resisting properties of the road mixture.

Simplification.—The greatest drawback to a systematic and complete study of the bituminous work being done throughout the country in which fluid asphaltic materials are used, has been the variation in tests methods and specifications controlling these products in the several states. The United States Bureau of Public Roads and the Asphalt Institute have secured the cooperation of the states and producers in testing all the liquid asphaltic products according to their own method and according to the scheme of analysis given below.

After testing their fluid asphaltic materials by this scheme, it is hoped that the various states can agree as to methods and tests so that a uniform system of testing and specifying may be adopted throughout the country.

METHODS AND USE OF TESTS IN COOPERATIVE SCHEME OF ANALYSIS

1. Flash point:
   a. Cleveland open cup for all products having a flash point above 175°F., A. S. T. M. Standard Method D 92-94.
   b. Tagliabue open cup for all products having a flash point of 175°F. or less. Method approved by the Bureau of Explosives.
2. Consistency:
   a. Viscosity, Furol, A. S. T. M. Standard Method D 88-30. In case of doubt as to which of two temperatures should be used in the viscosity determination, tests should be run at both temperatures.
      (1) At 77°F. for dust layers, primers, and all products which are applied without warming.
      (2) At 122°F. for all products including cut-backs which may be slightly warmed before application.
      (3) At 210°F. for all highly viscous products which must be heated to approximately 200°F., or above, before application and which have a viscosity of less than 300 sec. at this temperature.
   b. Float test at 122°F. on materials having a viscosity, Furol, of over 300 sec. at 210°F., A. S. T. M. Standard Method D 139-27.
3. Distillation, for all products—A. S. T. M. Standard Method D 20-30 with the following exceptions:
   Sample distilled shall be 200 c.c., the weight of this volume to be calculated from specific gravity at 60°F.
   Bulb of thermometer shall be immersed to a point ¼ inch above bottom of flask.
   Condenser shall be water cooled.
   Distillate shall be collected continuously in a 100 c.c. graduated glass cylinder and volume per cent off shall be recorded for every 18°F. (10°C.) starting with 212°F. (100°C.). Distillation shall be stopped at 680°F. (360°C.) and the entire residue shall be immediately poured into standard penetration containers and allowed to cool for further tests.
4. Tests on residue from distillation:
   a. Float test at 122°F. on all residues of over 300 penetration at 77°F. (100 gr., 5 sec.). Float tests at 122°F. of less than 25 seconds are not recommended. A. S. T. M. Standard Method D 139-27.
   b. Penetration at 77°F. on all residues of less than 300 penetration (100 gr. 5 sec.) A. S. T. M. Standard Method D 5-25.
   c. Ductility at 77°F. on all residues of less than 200 penetration at 77°F. (100 gr., 5 sec.) A. S. T. M. Tentative Method D 113-26T.
   d. Solubility in carbon disulphide—all residues. A. S. T. M. Standard Method D 4-27.
5. Solubility in naphtha—Method No. 46 American Association of State Highway Officials:
   Per cent insoluble in 86° A. P. I. naphtha of all original materials which yield a distillation residue of less than 25 sec. float test at 122°F.

A partial study of the results of this cooperative project seems to show that the proposed tests are reliable, that the producer and state testing laboratories check very well; and that an adequate indication of the probable behavior of the material on the road may be secured by means of these tests. It is believed that this simplified system of testing will show the original consistency and workability of the material, the speed of drying (rate volatile matter is lost) and will give an indication of the consistency of the material which will ultimately make up the finished surface.

Analyses of typical road oils are given in Table 7.

The Hobo Engineer

From *New Mexico.*

SOMETIMES, I think I'll quit this life,
And settle down and get a wife
And raise some children, too. By Jove!
I often think that I would love
To have some place I could call home
And settle down, no more to roam.
But—hell! That very thing I've tried
And found myself dissatisfied,
I've often tried to settle down,
To office work and live in town,
To act like civilized folks do,
And take in shows and dances, too.
But I've no more than made a start,
When wanderlust would seize my heart,
And in my night dreams I would see
"The great White Silence" calling me,
And at the summons I'd not fail,
"To bunch it all and hit the trail"
Back to the solitudes again,
With transit, level, rod, and chain,
To lead the simple life once more,
To do the same things o'er and o'er,
My resolutions always seem
To end up in a lovely dream.

When day would give way to the night
And recreation seemed alright,
I'd join the boys and we would go
To town to see a burlesque show,
Or seek a little fun and,—well
We'd sometimes raise a little hell.
We tried to crowd into one night
The joys of many months—"taint right,"
But you would do the same, I'll bet;
In fact, you would be playing yet.
For when we hit the "Great White Way,"
Temptations great and small held sway.
When our final survey is o'er
And we go to the Golden Door,
Admitting play and hard work, too
Done by all in the survey crew,
I'm sure the angels will decide
A balance on the credit side.
Then all our foolish little sprees
Will seem as ponds compared to seas
In light of dangers once endured
So best results might be secured.
And no one then need shed a tear.
But bless the Hobo Engineer.

—Anonymous.

Brick Manufacturers Discuss Recent Practical Developments in the Design and Construction of Brick Pavements

BRICK pavements have been laid on various types of base courses, both flexible and rigid. In the southern section of the country, especially, brick surface courses have been very successful on such foundations as natural sand, Florida lime rock, crushed slag, crushed stone, chert and gravel. In the northern parts of the country, brick pavements have given satisfactory service on water-bound and bituminous macadam base courses, well-drained gravel, and, in a few instances, on hot mixed "black base." In the steel manufacturing districts there are a number of installations on compacted granulated (water-cooled) blast furnace slag bases. Concrete is the material now in most general use as the foundation course. In most instances, plain concrete has been used, although in several localities, steel reinforcing is included.

Surface unevenness caused on account of cushion material filtering into base cracks has recently brought about considerable sentiment in favor of designing concrete bases with transverse and longitudinal joints providing for contraction and expansion. The contraction joints are usually of the weakened plane type filled with bituminous material and covered with a strip of burlap; the expansion joints are of the open type sealed at the bottom with bituminous material and covered with a strip of light guage metal. This design provides for crack control as well as stresses in the slab, a matter which has been generally neglected in concrete base design. It is false economy to attempt to save money by placing a high-class top on an inadequately designed base.

A present-day brick pavement is designed with a much thinner cushion course, than formerly, and of uniform thickness. This is possible because modern specifications require the base course to be finished practically as smooth as the surface of the road. The bedding course should not be thicker than one inch and, preferably ¾ of an inch.

Fine stone and slag screenings have been used successfully as they have cementing qualities which will bond them together; this material should also be sprinkled before rolling to insure compaction and cementing action.

A development of recent years is the use of a sand mastic mixture for the bedding course. This type of cushion is required in the latest specifications of the Illinois Highway Department and has been used on the brick resurfacing projects constructed this year in that State. Other recent projects on which bituminous mastic cushions have been used are in Olean and Auburn, N. Y. It was also used in Mattoon, Ill., in 1923 and '24 in the proportions of 96 per cent sand and 4 per cent by weight of light refined tar.

On the Illinois work 6 to 7 per cent of bituminous material by volume seemed to give best results. The mastic was mixed in paving mixers and in some cases in an asphalt plant. Best results were obtained in the asphalt plant due probably to better drying facilities. Difficulty was encountered in some cases in properly rolling the material which probably was due to the mixing being done too far ahead of actual use this having permitted some of the volatile solvents to evaporate.

National Paving Brick Manufacturers Association Hold Annual Banquet at Chicago Convention

With brick the trend is toward the increased use of a lug type which will insure positive separation of the joints and permit more thorough penetration of the filler. The lug brick has always been used more extensively in the East and, according to recent reports, will be required in certain sections of the West where lugless brick has heretofore been used. A type of lug brick introduced recently that is meeting with much favor, is what is known as the wire-cut brick (vertical fiber) with lugs. This differs from the wire-cut lug brick in that the wire-cut (instead of the die) side is in the surface and the wire-cut surface provides an additional non-skid feature.

The workmanship on laying brick pavements has been improved materially through requirements of the modern brick paving specifications. The Illinois and the Pennsylvania Highway Department specifications require a smoothness of ⅛ in. in 10 ft. There is no reason why the brick pavement should not be constructed as smooth as any other type, as the surface contour can be readily adjusted during construction and later, after the pavement is under traffic.

The filler now being used in practically all brick paving construction is a bituminous material—in a great majority of the cases, straight asphalt.

The grief encountered on account of unsatisfactory fillers has called for considerable study during the past two years. The most serious trouble has been bleeding of the filler during hot weather and slipperiness caused by some the filler remaining on the surface for a period of time after application.

Some reference has been made to the coating of the surface with certain materials which would prevent the adhesion of the filler. This has proven to be effective but great care should be taken that none of the material creeps down along the sides of the brick and prevents adhesion where it is needed. The use of coarse grit (not sand) rolled into the surface immediately after application has been found to be of considerable value in preventing slipperiness and it also peels off the surface in a better manner. The tendency seems to be in favor of a harder filler; the soft fillers which have been used during recent years were to some extent the result of necessity brought about by the use of a lugless brick, which has now been largely discontinued. The harder fillers seem to hold their place satisfactorily; they do not soften enough to cause any trouble and they become brittle enough during cold weather that the excess soon chips off the surface.

A mastic asphaltic mixture, consisting of about 25 per cent of sand or fine mineral aggregate, has been used successfully in the cities of New Orleans, La., and Jacksonville, Fla. The aggregate content, of course, increases the stability of the filler and decreases its tendency to bleed or flow at high temperatures. It should be noted that both of these cities are located in the far South. Trinidad Lake asphalt, which contains from 25 per cent to 35 per cent of mineral, was used this year in Richmond, Va., on a small area. According to reports the results were very good.

Experimental sections of brick pavement were filled with emulsified asphalt by the Ohio State Highway Department. The joints were first swept full of a very coarse sand and the asphaltic emulsion then applied cold with a truck pressure distributor. Another experimental section was filled with regular asphalt filler to within ¾ in. from the top of the surface; the following day coarse sand was brushed in and the filling completed with emulsion. Some excellent results have been obtained with emulsions in refilling jobs, especially where the old filler was still in place in the lower half of the joint. It is quite advantageous to use emulsions in emergency repairs especially during such seasons of the year when damp or cold weather is encountered.

Even with an ideal filler the results will be unsatisfactory if there is poor workmanship in its application.

Modern specifications also specify a minimum thickness of the surplus asphalt remaining on top of the brick. This is usually limited to 1/32 of an inch. Another method that has been used to a limited extent, is to coat the surface of the brick with a material that will facilitate the removal of the surplus asphalt after the application. Materials that have been used and proposed for this purpose are ordinary whitewash, light oil, and sodium silicate.

One of the most important uses which is being made of paving brick is that of resurfacing old pavements which are beginning to show signs of weakness and deterioration. This resurfacing is usually performed in conjunction with the widening of the old pavement. In case the widening is slight (from 2 to 4 ft.) it is usually done by constructing header curbs equivalent to the extra width aand resurfacing the old pavement. In case the widening is sufficient to warrant the construction of any base, the edge of such new base should be anchored under the edge of the old pavement. Careful inspection of the condition and value of the old pavement should be made and all sections which are in doubt should be reconstructed. It is considered to be better practice to resurface an old pavement before it has gone beyond the danger point of salvaging, rather than to wait until it doubt as to its value as a base.
has deteriorated to such an extent that there is serious

It is believed that the use of brick for gutters or combined gutter and parking strips on bituminous paved streets is on the increase. The advantages of this design are that it permits the thorough compaction of the bituminous material next to the gutter, maintains a true and even flow line, will not deform under the weight and grind of parked and moving motor vehicles, and resists the chemical action of gutter fluids.

For street-car track paving, the trend is away from the use of specially shaped brick adjacent to the rails, when T-rails are used.

A novel test pavement in which vitrified brick were used is that constructed by the Board of Transportation of the City of New York, on East Kingsbridge Road. One section, 60 ft. in length, consists of a Tri-Lok metal grating 3 in. in depth, filled with 2½ in. x 2½ in. x 1⅞ in. vitrified brick blocks set in cement mortar. The purpose of this test is to determine the suitability of removable pavement sections to be used in paving the vehicular tunnels that are proposed under the waterways surrounding the city of New York. This test pavement was opened to traffic in July, 1931.

Gravel Roads Break Up

Rain and thawing weather preceding the recent snow fall left many icy and slippery stretches on the trunk highways, the weekly road condition report issued Feb. 19 by the Minnesota highway department states. In the southern part of the state many of the gravel roads became badly rutted during the warm weather, and the colder weather left them unusually rough. Cautious driving is advised on all routes. Many of the routes were temporarily blocked by snow and drifting at various times during the past week, but all are now open.

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

A Discussion Concerning

ADHESION TENSION *in Asphalt Pavements*

Its Significance and Methods Applicable In Its Determination

By VICTOR R. NICHOLSON
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First Installment

This article as it appears here does not seem to follow the title. It is because this is only the first part of three installments. Because colloids play such an important part in the ability of the asphalt to adhere to mineral aggregate, it is deemed advisable to explain some of the properties of colloids first.—Editor.

FIVE years ago this coming spring, the Street Department of the City of Chicago, at my suggestion laid a sheet asphalt pavement using a formula derived from a stability study of coarse concrete sand. This pavement was made with a pit sand somewhat coarser than that ordinarily used in sheet asphalt, with 12 per cent of 200 mesh limestone dust, but only 8 per cent of bitumen, in contrast to the 10 per cent ordinarily used. This mixture when compressed to ultimate density showed only 3 per cent of voids, and the calculated film thickness of asphalt around grains of sand was no less than that in our ordinary sheet asphalt mixtures. This pavement has given very good satisfaction, not showing any tendency toward waviness, and would be 100 per cent perfect if the sand grains on the surface had not become partly white and bare of asphalt. This surface whitening made itself manifest the very first summer it was laid, and was as bad in the places where no traffic hit it as where the automobiles traveled. This condition is not confined to this particular type of pavement only, but is plainly noticeable on sheet asphalt pavements using a fairly coarse sand, and very noticeable on streets laid with asphaltic concrete and penetration macadam.

At the time this pavement was laid down the city had rock asphalt pavements laid with material from Kentucky, which were four years old, and even though they contained only 7 per cent of bitumen and a voidage content of 15 per cent, still the surfaces made therefrom retained their characteristic black color.

At the 1926 meeting of the Asphalt Paving Technologists, I presented a paper on the influence of the angularity of the sand grains on the stability of the asphaltic mixtures made therefrom. In that paper I compared the stabilities of such aggregates as crushed granite, extracted rock asphalt aggregate, crushed quartz, lake sand, and Ottawa sand in the order of their stabilities. The angular sands such as the granite, the rock asphalt aggregate, and the crushed quartz gave high stabilities while the rounded sands, the lake and Ottawa, gave much lower stability values.

At the 1927 meeting of the before mentioned technologists at Atlanta, Mr. A. W. Dow in a paper read there, presented the theory that the reason why I obtained such high stabilities on crushed quartz, crushed granite, and the extracted mineral matter from rock asphalt was, that these materials held some finely divided colloidal material on their surfaces. To quote from Mr. A. W. Dow's article: "If two pavement mixtures alike in every way as to composition, voids, etc., are tested for stability, the one containing the mineral aggregate with the highest absorptive value will show the highest stability." In another part of his article he points out that the absorption value is a measure of the colloidal content of the mixture. Therefore, it is fair to interpret the above quotation as meaning, that the sand showing the most colloid will give the highest stability. He explained that the colloid on the grain tended to make the asphaltic coating on the grains thicker, which thus made the resulting mixtures more stable.

This view was later partly subscribed to by Prevost Hubbard in a paper, "The Chemistry of Bituminous Highway Construction: The Petroleum Asphalt," read on Feb. 15, 1929, before the American Section of the Society of Chemical Industry. To quote from this article, "From additional work that has been done, however, indications point to the fact that whether or not adsorption is directly responsible, those sands with high adsorption values (high colloid) possess more pronounced stabilizing characteristics than those with relatively low adsorption values, so that the two may go hand in hand."

However, I am not able to subscribe to all the points brought out in these papers for I know that the Ottawa Sand, mentioned in my 1926 paper, which gave by far the lowest stability test on sands studied must have contained much more colloid than either the crushed quartz or granite. This sand was prepared by crushing down a sand stone found near Ottawa, Ill., which in common with all sandstones, held a cementing medium between the grains in the form of dried out colloid which had been carried through the sand by the seeping waters of the ages past. The colloid present in the granite and quartz was not present in sufficient amounts or of proper character to give a good decolorizing test with the asphalt solution proposed by Dow.

A good deal of confusion exists as to what a colloid really is. During the last few years however, research chemists in this field have classified as colloids, mate-

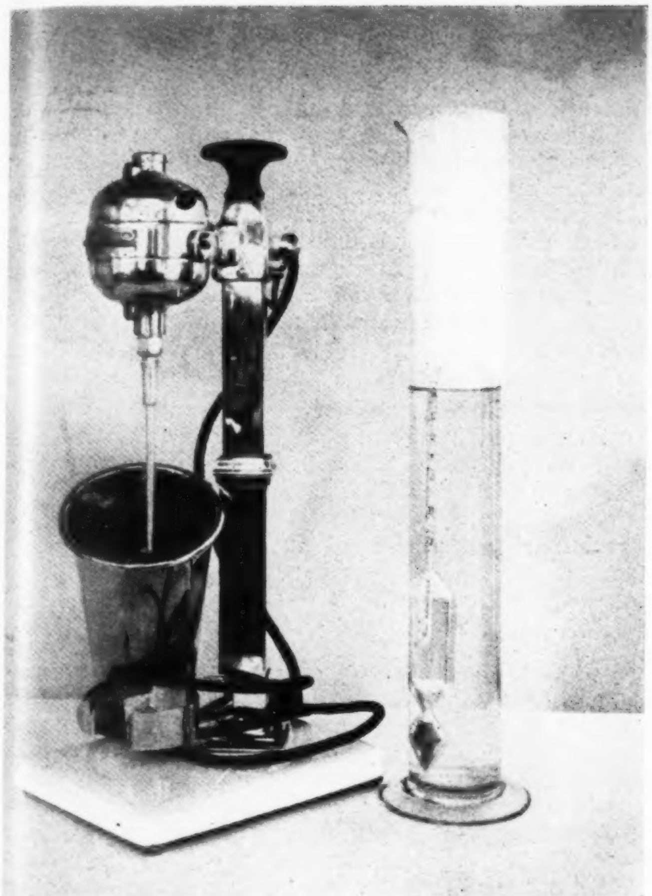

Fig. 1.—Determining Soil Colloids by the Hydrometer

rials which are extremely fine. Thus Atterberg working with clays, classifies as colloids, materials finer than 2 microns in diameter, a micron corresponding to .001 mm. Freundlich in his book on "Colloid and Capillary Chemistry" gives 0.5 microns as the upper diameter for this material. The size generally recognized by soil chemists in this country, is that used by the U. S. Bureau of Soils, which is 1 micron. By way of comparison, the opening in a 200 mesh sieve is .074 mm., or material just passing this screen is 74 times as large as material in a colloidal state. It has been pointed out by Dow and others that these fine colloids even though of the same fineness do not possess the same capacity for removing asphalt from solution. It has been shown in Dept. of Agr. Bull. 1132 that a quartz colloid may adsorb no dye from solution, whereas a material like clay may adsorb large amounts, and that the adsorptive capacity of any material is specific for that material only and not a general property of all other colloids. It has been shown in several bulletins published by the Illinois Geological Survey and other places, that these colloids can be made to stick in the dried state on silica so as to give tensile tests commensurate with that obtained with Portland cement, with the same amount of silica. However it can also be easily demonstrated, that when these same briquettes are immersed in water, they slake and lose all the tensile strength they exhibited in the dry state.

Prof. Bouyoucos at the Michigan Agricultural College has shown that by agitating a sample of colloidal soil in the apparatus shown in Fig. 1, with some water and alkali, that it is possible to remove or separate the

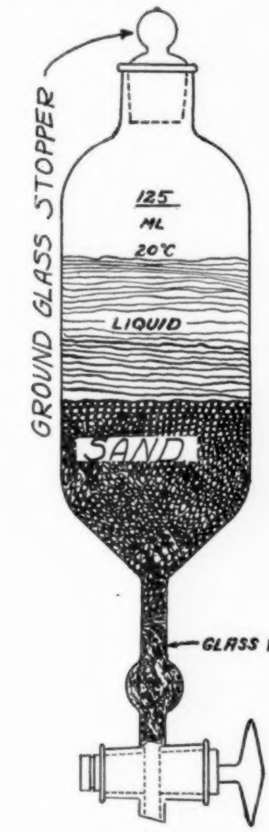

Fig. 2.—Absorption Bottle

TESTS ON SIEVED MATERIALS

No.	1	2	3	4	5	6	7	8	9	10	11
Kind	Washington	Washington	North Carolina	North Carolina	Atlanta	Atlanta	Quartz	Quartz	Quartz	Granite	Granite
Washing treatment	No	Yes	No	Yes	No	Yes	No	Yes	Colloid Tr.	No	Yes
Per cent colloids by hydrometer	1.5	No	2.0	No	1.5	No.	No	No	2.5	No	No
Grams asphalt removed by 1 gram mineral	.005	.002	.007	.002	.005	.002	.001	.001	.006	.001	.001
Grading of mineral aggregate passing 200 mesh	....	....	....	....	....	....	....	....	....	....	....
Passing 80 on 200	31.16	31.96	24.80	26.34	9.10	6.50	12.32	13.00	10.70	:19.8	18.4
Passing 40 on 80	44.00	42.60	36.06	35.74	41.80	42.90	32.08	33.16	32.00	20.7	19.6
Passing 20 on 40	18.54	19.16	35.60	34.82	42.70	44.12	41.30	42.14	42.10	25.8	27.4
Passing 10 on 20	5.16	4.88	3.54	3.10	6.32	6.28	14.30	11.70	15.20	32.7	34.6
Passing 4 on 10	1.14	1.40	....	....	.08	.20	....	....	....	....	....
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Specific gravity of mineral aggregate	2.599	2.594	2.643	2.659	2.659	2.674	2.612	2.612	2.634	2.643	2.65
Per cent oil asphalt added	8	8	8	8	8	8	8	8	8	8	8
Per cent 200 mesh filler	0	0	0	0	0	0	0	0	0	0	0
Theoretical density briquette	2.325	2.321	2.357	2.369	2.369	2.38	2.335	2.335	2.351	....	....
Density of briquette	2.028	2.004	2.024	1.972	1.944	1.911	2.009	2.027	2.057	....	....
Voids in briquette, per cent	12.77	13.66	14.13	16.76	17.94	19.71	13.96	13.20	12.50	....	....
Lb. stability	2,033	1,833	392	348	458	390	1,200	1,117	1,325	....	....
Per cent asphalt added	10	10	10	10	10	10	10	10	10	10	10
Per cent 200 mesh filler	10	10	10	10	10	10	10	10	10	'10	10
Theoretical density of briquette	2.283	2.279	2.310	2.319	2.319	2.328	2.29	2.29	2.304	2.309	2.30
Density of briquette	2.230	2.227	2.234	2.228	2.225	2.201	2.241	2.259	2.241	2.253	2.26
Voids in briquette, per cent	2.32	2.21	3.24	3.92	4.05	5.45	1.83	1.40	2.52	2.43	1.82
Lb. stability	2,658.000	3,033.000	892.000	1,066.000	1,558.000	1,542.000	1,633.000	1,608.000	1,350.000	1,312.000	1,500.000

colloid from the coarse constituents, and determine its amount in percentage by weight of total sample, by means of a hydrometer placed in a jar containing the suspension. This same method for determining the percentage of colloid can also be applied to sand. Even though a given sand may show a measurable amount of colloid according to this method it does not necessarily imply that colloid will show the property of removing asphalt from solution in a solvent.

The decolorizing action of various colloidal sands on asphalt solutions can be very beautifully demonstrated by the tube method used by Dow. In order to determine the actual amount removed, I prefer to use the adsorption bottle shown in Fig. 2, which has been specially designed for this purpose. This consists of a blown glass flask of about 150 cc. capacity, with a ground glass stopper, and connected at the bottom through a small bulb with a ground glass stop cock. In running the test the cock is closed and bulb above it packed with glass wool to prevent the sand from running through the stop cock when open. Fifty grams of the sand to be tested are then poured into it and 100 cc. of the asphalt solution added. The bottle is then corked and inserted in a rotating device which is given a rotation lasting 20 minutes at 8 revolutions per minute. The bottle is then removed from the machine, cork removed, bottom cock opened slightly and enough liquid is allowed to run into a test tube to give a good comparison with standards prepared according to the method of Dow. It is obvious of course that there is a wide variation in the adsorptive capacities of different sands. Thus ordinary Lake Michigan sand removes hardly any asphalt from solution while colloidal sands like those from North Carolina, Washington, D. C., and Atlanta remove considerable amounts as shown in the table of results. The crushed quartz and granite on the other hand do not remove any considerable amounts of asphalt. In running this test it is necessary to always use the same kind of asphalt, for the amount of color in solution will vary with the amount of asphaltenes present in the asphalt. In running tests shown in the accompanying table I used a 0.5 per cent solution of a very soft Venezuela oil asphalt in carbon disulphide.

In order to study the influence of the colloid on the asphaltic mixtures made therefrom, it is necessary to test the mixtures with the colloid present, and then with the colloid absent. For this purpose samples of colloidal sand was sieved free from any material passing 200 mesh. The total sieved sample was then very carefully mixed to be sure same was uniform throughout. It was then halved and one portion used in making mixtures numbers 1, 3, 5, 7 and 10. The other half of the sample was then subjected to Bouyoucos' method for removing colloids and after settling the sand the colloids were removed by decantation. Samples treated in this way were washed and decanted until the supernatant liquid was clear. The thoroughly drained cleaned sand was then put on a pan and dried of its water content in an oven. The dried colloid-free sand was then again sieved through a 200 mesh sieve and then again thoroughly mixed to insure uniformity.

On running tests on the crude and colloid-free sands for percent of colloids, by Bouyoucos' method, and the adsorptive qualities of the sand, it can be seen from an examination of the accompanying table, that removal of colloids was complete and the asphalt adsorbing capacity was brought down to that of silica. In the case of silica and granite, on account of their grading the mixture seemed to segregate, so after washing of same it was sieved and then the crude material made to conform to this grading by recombining the various screen fractions. Even with this precaution gradings do not seem to check as well as they could. Mixture under column 9 was made by taking the crude crushed quartz and coating same with 3 per cent of a fine adsorbent clay, using water and drying. After drying it was sieved into its components and recombined to conform with the other two samples.

As can be seen from table of tests two series of stability tests were run, one using 8 per cent of asphalt and 92 per cent of sand, and the other using 10 per cent of asphalt, 10 per cent of 200 mesh limestone dust, and 80 per cent of sand.

The asphalt used was an oil asphalt from Mexico having the following characteristics:

Penetration 77°F.	42
Loss, 5 hrs., 325°F.	.05 per cent
Ductility	115 cms.
Solubility CCl_4	99.80 per cent
Sp. Gr.	1.051

The limestone dust had a specific gravity of 2.838.

Tests for stability were run according to Hubbard's method, tamping and compressing at a temperature of 250°F. Samples were extruded, after storage over night at room temperature, at a temperature of 140°F.

It will be seen from an examination of the results of the tests listed in the table under sand and asphalt that the colloids present on grains seems to make mixtures more dense. In this series, mixtures showing a little bit of colloid seem to show a little bit higher stability than those without colloid. However, on making up sheet asphalt mixtures from these same sands the colloid-free sands show higher stabilities than those containing colloid.

As to the reason for the slight difference in results with plain and washed sands, it is in all probability due to the fact that the colloid on the grains tends to act as filler. There also is a possible variation in results due to the change in grading which takes place during the washing of the crude sand to free it of colloid. The most likely reason for the difference is that the variation is due to the error in making the stability briquettes. In practically every case the difference in stabilities between the plain and washed sands is no greater than that possible in running the stability test itself.

In no case is the difference in stabilities between the plain and washed sands enough to account for the differences shown in the paper I read in Washington.

Without Mentioning Hospital Bills

Speed comes high, according to investigations made by the Chicago Motor Club. An Associated Press despatch says that the investigators are convinced that a mile-a-minute clip is from three to four times more expensive than when your speedometer says 40 to 45. After checks made at various speeds, they came to the following conclusions:

Oil consumption at 55 miles an hour is seven times greater than it is at 30.

Tire wear at 50 is twice as much as at 40.

Gasoline consumption at 55 is one-fourth more than at 30.

No estimate is made of the increased wear and tear on the car at the higher speeds.—*Minnesota Highway News.*

Where the Highway Dollar Goes
Labor's Share Around 90 Per Cent

A STUDY to determine the extent to which expenditures for highway improvement provide employment has just been completed by the Bureau of Public Roads of the U. S. Department of Agriculture. Concrete pavement was selected for this study because it is a widely used type, and because the effect of expenditures for pavements of this type in providing employment is believed to be typical of the effect produced by expenditures on other high-type pavements. The effect in this field also appears to be typical of that produced by expenditures for public works generally.

Influence of Construction on Employment.—All forms of construction have a wider influence on employment than appears generally to be recognized, though the points at which this influence is applied differ. An expenditure for the erection of a steel bridge probably results in about the same gross payment to labor as the same expenditure for a concrete pavement but the distribution of the payments that are made to labor affect a somewhat different group of industries and in neither case is the distribution the same that results from the construction of a monumental building. But this is of little consequence, for, though this distribution reaches different industries, in all of these cases the general effect on business and on employment appears to be about the same.

In making this study, expenditures were traced through the various industries that are affected by them and the amounts paid as wages and salaries were set aside for accumulation. In the end, labor was found to receive the larger part of these expenditures, which is an altogether reasonable conclusion, since the materials entering into highway construction are of little value in their original state. Practically all of the value which the finished pavement possesses is created by the application of labor directly and through manufacturing processes and transportation.

Subdivisions of Cost of Pavement.—For the purpose of indicating how labor creates the value of the finished concrete pavement, the following primary subdivision of its cost was made:

1. The direct cost of laying concrete pavement (production expense).
   a. Labor.
   b. Aggregate.
   c. Cement.
   d. Steel.
   e. Equipment.

These items cover the labor employed in connection with the various operations incident to laying the pavement, the cost of the materials of which the pavement is composed, and the costs represented by the equipment used.

2. Expense, other than for production, incurred in connection with laying concrete pavement.
   f. Getting onto job and installation of plant.
   g. Bonds and insurance.

The first of these items covers the preliminary expenses incident to this work such as the cost of getting equipment onto the job, the cost of employing men, the cost of developing a working organization, et cetera. The second item covers the cost of bonds and insurance and all closely related costs.

3. Job margin.
   h. Overhead.
   i. Financing.
   j. New profit.

Such items as overhead (which includes central office salaries, rented quarters, the cost of bidding, et cetera) and the cost of financing must be paid out of the job margin. After these and related expenses are satisfied, the remainder is the net profit on whatever money is invested in the enterprise.

Cost of Laying Pavement Analyzed.—An extended analysis of the cost of laying concrete pavement in three typical states during the calendar year 1929 produced the following distribution of cost among the above-named items:

TABLE I

	Cents per Sq. Yd.	Dollars per $1,000 of Expenditure
Item a. Labor	$0.26	$141
Item b. Aggregate	.60	324
Item c. Cement	.60	324
Item d. Steel	.05	27
Item e. Equipment	.18½	100
Item f. Getting onto job and installation of plant	.05	27
Item g. Bonds and insurance	.04	22
Items h, i, j. Job margin	.06½	35

In order to ascertain the amount of labor inovlved in each of these items (except Item a, which already is a labor item), the study included an intensive analysis of their component parts. This analysis resulted in a distribution of the costs these items involve under nine headings—labor, freight (principally railroad freight), materials and supplies, fuel, interest, taxes, depreciation and repairs, depletion and profit. Freight charges cover both the cost of delivering finished materials to the materials yard of the job and the cost, if any is involved, of accumulating the raw materials, fuel, etc., used in producing such manufactured materials as cement and steel. The details of these analyses are not repeated here but the results appear in Table II.

The largest single item in Table II is "Freight—$406.70" which is about 40 per cent of the cost of concrete pavement construction. Of this amount $313.70 is for transportation of aggregate, cement and steel. It covers the collection of the components of these materials prior to their manufacture, and the shipment of the material to the construction jobs. The cost of assembling the materials out of which they are built is nearly a third of the total cost of concrete pavements. The remainder of the freight charge is for the equipment and the movement of the numerous materials that enter into the manufacturing processes and subprocesses other than those noted above.

If this item (freight) is distributed on the theory that the railroads handle this business, the distribution shown in Table II reduces to that shown in Table III. While by far the larger part of this freight is handled by the railroads, a little moves by water and a some-

TABLE II—SUMMARY OF VARIOUS STEPS THROUGH WHICH CONTRACTOR'S PAYMENT OF $1,000 ARE TRACED, AND THE AMOUNTS ATTRIBUTABLE TO EACH

Item	Salaries and Wages	Freight	Materials and Supplies	Fuel	Interest	Taxes	Depreciation and Repairs	Depletion	Profit	
a. Salaries and wages	$141.00	....	....	....	....	....	....	....	....	
b. Aggregate	50.00	$194.00	$18.00	$11.00	$ 4.00	$ 6.00	$29.50	$ 7.50	$ 4.00	
c. Cement	61.00	113.50	30.00	22.50	4.50	5.00	53.50	3.00	31.00	
d. Steel	6.00	6.20	8.50	1.50	.40	.90	2.50	....	1.00	
e. Equipment	5.20	4.50	10.65	.50	.20	7.20	70.65	....	1.10	
f. Getting onto job	13.50	13.50	....	....	....	....	....	....	....	
g. Bonds and insurance	11.00	....	....	....	....	....	....	....	1.00	*$10.00
h. Job margin	15.00	....	....	....	5.00	5.00	....	....	10.00	
	$302.70	$331.70	$67.15	$35.50	$14.10	$24.10	$156.15	$10.50	$48.10	$10.00
†Adjustments		+75.00	—50.00				—25.00			
	$302.70	$406.70	$17.15	$35.50	$14.10	$24.10	$131.15	$10.50	$48.10	$10.00

*Set aside for later redistribution. †These adjustments are made here to avoid recasting the freight analysis on account of the freight charges which are a part of the cost of repairs, replacements, materials and supplies.

what larger volume is moved in trucks. However, substantial accuracy is preserved if all of it is treated as railroad business.

TABLE III

1.	Salaries and wages	$477.70
2.	Materials and supplies	57.55
3.	Fuel	57.20
4.	Interest	61.70
5.	Taxes	49.70
6.	Depreciation and repairs	184.65
7.	Profit	91.00
8.	Depletion	10.50
9.	Redistribution	10.00
		$1,000.00

If the cost of fuel as shown in Table III is distributed between the remaining items, Table IV results.

TABLE IV

1.	Salaries and wages	$516.00
2.	Materials and supplies	64.20
3.	Interest and rents	63.75
4.	Taxes	51.40
5.	Repairs and depreciation	188.75
6.	Profit	91.00
7.	Depletion	14.90
8.	Redistribution	10.00
		$1,000.00

From the last of these tables it is clear that although job labor receives only a little more than 15 per cent of the sum expended on the construction of a concrete pavement (see Items a and f of Table II), the labor involved in producing the materials of which such pavements are constructed, in transportation and in obtaining the necessary fuel, is so large that the distribution to salaries and wages on account of these phases of the construction of such pavements is well in excess of half of its total cost.

Of the other items that appear in Table IV, there are three, "Repairs and depreciation," "Materials and supplies" and "Taxes" which evidently involve a large expenditure for salaries and wages. The ramifications of the first two of these classifications involve so many manufacturing processes that a more generalized analysis was applied to their reduction. However, though more generalized the line followed was the same as that used in examining the expenditures of which there is more exact knowledge. This analysis is not repeated here but when Table IV is amended in the light of this analysis and in the light of the use made of taxes in paying employees and purchasing materials, it is found that as these payments filter through the various industries affected by them, something more than three-quarters of the money paid to contractors is converted into salaries and wages and less than one-quarter becomes the property of owners, who receive it in the form of interest, rents, royalties and profits.

This is about as far as the quantitative analysis may be carried with approximate certainty. But, although the quantities become somewhat doubtful, there is still a further share for labor in the last quarter of the expenditure.

Labor Receives About 90 Per Cent of Total Expenditures.—The preceding quantitative discussion is based on a period of unusual business activity. In times of depression such as the present, the residue composed of interest rents, royalties and profits shrinks both in absolute amount and in relation to the total. In view of this well known fact, it seems probable that, of the total expenditures for road construction at the present time, nearer 85 than 75 per cent may be thus directly traced into the hands of labor. Beyond this, there is still to be considered the fact that a part of the money paid to owners is immediately reinvested or expended, even in periods of depression, although a greater part is certainly so used in more prosperous times. And since, of the money so reinvested in productive industry, labor again receives the major part, it is not unreasonable to suggest that as much as 90 per cent and probably more of the original expenditure for a concrete pavement ultimately finds its way into wages and salaries and that this percentage is not greatly changed by the turn of the cycle from prosperity to depression and back again.

Longest All-Welded Bridge Is Completed in Pilsen

A highway bridge recently completed in Pilsen, Czechoslovakia, is reported to be the longest all-welded steel bridge in existence, according to Commercial Attache K. L. Rankin, Prague, Czechoslavakia, in a report to the Department of Commerce.

No rivets or bolts whatever were used in its construction. The bridge crosses two railroad tracks and has a span of 161.4 feet and a width of 27.4 feet. The total weight is 145 metric tons, which is claimed to be 30 tons or nearly 21 per cent less than a riveted structure designed for the same stresses. Loading tests made after completion of the bridge showed a deflection of 21½ per cent less than had been calculated, evidencing the great stiffness of welded construction.—*Issued by the Department of Commerce.*

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

EDITORIALS

The Silver Lining

IT WAS a sort of gratification to me to know that efforts have considerably advanced, in the face of adversities, to simplify the muddled situation in which the asphalt producing industry finds itself. Yesterday and the day before I sat at a meeting in Chicago at which the testing engineers and chemists of the Upper Mississippi Valley Region of the State Highway Departments were meeting with representatives of the Bureau of Public Roads and the Asphalt Producers for the purpose of simplifying tests on liquid asphaltic products. This meeting was one of four that are being held in various parts of the United States. At the time of writing, the Eastern group had had their meeting, the Western or Pacific group had met and the Southern group was due to meet at New Orleans in a week or two.

For the last twenty years the asphalt producers themselves have been considerably responsible for lack of clarification, simplification, and standardization of asphaltic highway materials. Through the efforts of the Asphalt Institute and the Bureau of Public Roads the producers finally got together and have agreed upon certain tests by which liquid asphaltic products, cut backs, and semi-solid asphalts may be identified. This movement started about four years ago. In the intervening period thousands of tests have been made both by the producers and the state highway department testing engineers as well as by chemists and engineers of the Bureau of Public Roads as a basis for setting up a simplified set of tests. The meeting in Chicago was held for the purpose of approving the cooperative simplified tests. Mr. J. T. Pauls has been conducting the meetings for the Bureau of Public Roads. Mr. Prevost Hubbard of the Asphalt Institute has been acting as secretary and spokesman for the producers.

In order to arrive at a common meeting ground the country was divided into regions so that regional meetings could be held. It would be much easier to get regional groups together than the entire country. Furthermore, because of the origin of the various asphaltic materials it seemed best to divide the country up into these four separate regions. A tremendous amount of testing and investigative work has been done and the expenditure of thousands of dollars necessary to bring this cooperative system of tests to the stage at which it is now being presented to the various states. All those testing engineers, producers, and chemists who participated in this tremendous venture are to be commended upon their energetic work and their desire to reduce the number of grades of asphalt required of the producers.

While casual observance to the proceedings at this meeting would lead one to believe that testing engineers were somewhat reluctant to change their methods and test specifications, nevertheless, there is a wholehearted cooperation among the engineers to arrive at some standard basis by which various oils can be compared. Certainly the industry needs some sort of standardization so as to cut down the number of grades of asphalt that have to be produced. The tests that were made which formed the foundation of the simplification program covered every single liquid asphaltic product made by every asphalt producer in the country. Gallon samples were sent to each state of the grades that would meet all of the specifications in that state. The samples were tested by the state's own specification and then also by the simplified cooperative methods. This same procedure was done by the Bureau of Public Roads and also by the producers themselves. All these results, tabulated by states and producers, were analyzed.

After the test standards have been arranged the next step will be to establish limits of tolerance for each test. One is constrained to admire the stamina and fortitude required of the cooperative group in carrying out the tremendous amount of detailed analysis necessary as the foundation work. There are always two sides to an argumentative subject. One can readily see why testing engineers and chemists would be reluctant to change their tests and specifications to something quite different than that in which the various men have been drilled. It would become necessary for them to change their entire specifications and to coordinate, again, the test with the behavior of the material when used in road work. A gigantic stride has been accomplished as a result of these regional meetings. If future endeavor is accomplished at the same rate and with the same interest as has been exhibited in the past there is no doubt that within the next two years the present muddled condition of the industry will be immensely clarified. Tests should be so clarified that comparison between various road oils and liquid asphaltic products could be made by the average engineer. I look forward to this desirable result. The Asphalt Institute, The Bureau of Public Roads, and the Asphalt Producers deserve considerable credit for the efforts as far as they have gone.

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Why Test Materials?

THE value of tests on any material lies in the significance of those tests when studied in conjunction with the behavior of the material when put to technical service. An article in this issue by Mr. R. H. Lewis of the Bureau of Public Roads explains why tests are made on various bituminous products and what the meanings of those tests are when correlated with the actions or the characteristics of the material when incorporated in a road surface. When studied by the asphalt chemists these tests disclose the physical and chemical constitution of the material with which the chemists are dealing. That in which the engineer is interested is the economic employment of satisfactory bituminous material for highway construction and maintenance. Tests, therefore, on bituminous products must sooner or later be correlated to the economic employment of the material in road construction work. The article by Mr. Lewis should prove of considerable value to the average engineer because it explains why certain tests are made on asphalt products and what the test is supposed to reveal.

The second part of this article will be run in next month's issue. It covers the tars and bituminous emulsions.

Mr. Congressmen—Think!

MR. SENATOR! Mr. Representative! Did you ever sit down and calculate in cold dollars and cents the profits that highway investments return? They are more than profits, they are equitably apportioned dividends. I shall briefly analyze this situation now.

Assume for the time being that you are a capitalist with $2,000,000,000 available for investment. You are seeking the greatest return, naturally, that you can get for that investment, commensurate of course, with safety of the investment. You would not invest it in fly-by-night enterprises neither would you invest it in rain-making schemes in a drouth. Both of these projects offer lucrative profit IF they were substantial enough to return the investment.

On the other hand you would not, at the present time, invest it in European bonds. While some bonds may return the investment at a low rate of interest over a period of generations, others may never be paid; the investment never returned.

Why not analyze government business just as you would your own? Put yourself in the position of being direct administrator for $2,000,000,000 of government funds, state and federal. This is about the amount that has been spent annually in the past for road and street improvement. Would you recommend to Congress to increase this amount, or would you recommend a decrease? Why?

After a little study you would recommend an increase. And here is why.

The public cannot by any stretch of the imagination be conceived to have more than a remote conception of the economic loss that results from lack of highway construction. This loss is unquestionably enormous when taken in the aggregate and is made up of millions of small items that are concealed in those every day expenses of vehicle operation over poor roads that are taken as a matter of course.

The public can not sense that there are broad economic problems involved in the development of a national highway system and can but dimly comprehend the basic principles when they are expounded.

Our total motor vehicle cost of operation runs about $20,000,000,000 annually. This is based on vehicle registrations of approximately 26,500,000 as recorded by the Bureau of Public Roads. The annual cost of operation is determined by adopting the cost of operation figures recently published by the Iowa Engineering Experiment Station, Ames, Iowa, which gives the cost of the average passenger automobile as 5.94 cts. per mile with an annual mileage of 11,000. Commercial vehicle costs will run 15 cts. per mile and average 15,000 miles annually.

If you could save 10 per cent of this cost of operation you could pay for all the road construction work required annually in this country. It is not possible to plan and construct highway systems strictly upon the basis of economic principles for the reason that, considering our highway systems as a whole, the expenditures economically justified would be, as a usual proposition, exceedingly beyond the practical limitations of available funds. Even under present conditions it is seldom possible to make all the improvements which would be sound investments because of the lack of funds.

Value is defined in the ordinary conception of the term in such way as to indicate that it is related to income-producing ability. But, since highways do not produce income in the commercial sense, they do cause savings from expenditures, for motor vehicle operation which represent an income that would have been expended had it not been for the highway improvement.

To develop the $20,000,000,000 operating cost to which reference has been made the average automobile operating over the average road was employed. Experiments carried out by the Iowa Engineering Experiment Station show that untreated surfaces and unimproved roads cause twice the tire wear as roads with some type of bonded surfacing. They also show that operating costs on untreated low grade surfaces are 20 per cent greater than on bound surface treated roads. You need only to take 20 per cent of $20,000,000,000 and find that the annual saving in operating cost is double the capital over which you have supervision for investment.

Now then, this $4,000,000,000 is a straight, tangible, evident, dollars and cents saving. Any economist will tell you that you may capitalize this saving at a fair rate of interest for the length of economic life of the improvement to ascertain a justifiable expenditure for making the improvement. Let us adopt a low rate of interest, say 4 per cent, and a short economic life, say 5 years. The capitalized value of this saving under these conditions is $17,800,000,000. That is the sum that you may feel justified in spending to save $4,000,000,000 annually. .

But—Mr. Congressmen, Mr. Legislator—in your original setup you were given jurisdiction of only half of the amount that improved highways will save for the motor-vehicle operator in gasoline, oil, and tires alone. Now what would be your recommendation relative to increasing or decreasing the capital intrusted to your judgment for expenditure?

Your unqualified recommendation would be INCREASE THE FEDERAL, STATE, and COUNTY HIGHWAY APPROPRIATIONS.

The investments made in highway improvements, you would say, earn tremendous dividends. You would realize that the $2,000,000,000 you had to invest for the public would be returned to them before the end of the first year, with interest.

In making these recommendations you would not have had to resort to any hypothetical values as, value of highway for social benefit, value to rural education, value of market advantage, value of satisfaction of being able to go anywhere anytime, value of time saved, value of increased property valuation, value of diminished wear and tear on motor vehicle equipment, or value of improved mail service.

The safety of the investment is so self evident it would be an insult to ordinary common sense to discuss it.

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Telegraph—Don't Write!

"NOW is the time for all good men to come to the aid of their"—industry. Bad men too, as far as this is concerned. Federal aid highway appropriations are in danger of being cut. Both the regular and the emergency appropriations need the support of everyone connected with the highway industry. We urge you to write to your senator and your representative voicing your views on the necessity of continuing Federal Aid. For some ideas on this see pages 124 and 125.

Telegraph your congressman to support federal aid highway appropriations! Do it now!

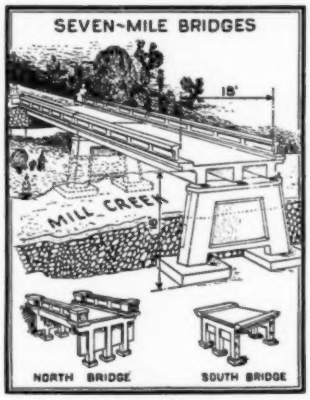
V. J. Brown

County and Township Roads

OFFICIAL DOPE SHEET

Information About The Seven Mile Bridges, Walla Walla County, Washington

CALL FOR BIDS. At 11 a. m. Friday, March 28, 1930, the board of County Commissioners of Walla Walla County will open bids for the construction of three reinforced concrete bridges and culverts at the Seven Mile Crossing of Mill Creek near the Northern Pacific siding at Tracy, seven miles east of Walla Walla. The main structure is made up of three 36-foot T-beam spans. Twenty-foot and fourteen-foot spans are proposed for smaller crossings north and south of the main bridge. Thirteen hundred feet of grade and approach fill is included in the contract. Foundations of the three structures is creek gravel.



QUANTITIES: The larger quantities include:

MAIN BRIDGE

Excavation, Structure	350 cu. yds.
Concrete	330 cu. yds.
Steel Bars	41500 lbs.
Borrow	4800 cu. yds.
Largest Pouring	34 cu. yds.

NORTH BRIDGE

Excavation, Structure	53 cu. yds.
Concrete	37 cu. yds.
Steel Bars	6100 lbs.
Largest Pouring	24 cu. yds.

SOUTH BRIDGE

Excavation, Structure	30 cu. yds.
Concrete	21 cu. yds.
Steel Bars	4200 lbs.
Largest Pouring	12 cu. yds.

PRICE OF CEMENT: Local dealers quote the following price for cement F. O. B. cars at Tracy, $3.91 per bbl. gross, with $.10 per bbl. discount for cash and an allowance of $.10 each for sacks returned.

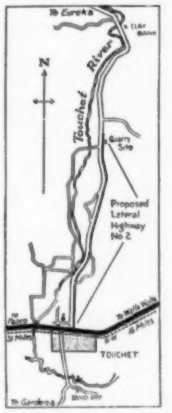
DATE OF COMPLETION: The date set for completion is December 1st, 1930. The call for bids is officially advertised in the Waitsburg Times of February 28th, March 7th, and 14th. Specifications are Washington State Standard. Plans are on file in the office of County Engineer, Walla Walla, in the office of the Pacific Builder and Engineer, Seattle, and in the offices of the Associated General Contractors, Spokane, Portland, and Seattle. A deposit of $5.00 is required to insure the safe return of the plans on or before the time of the opening of bids.

THE BOARD of County Commissioners of Walla Walla County is made up of C. E. Cummins, Touchet, Chairman; Henry Copeland, Walla Walla, and C. N. Eaton, Waitsburg. A. C. Moore is Clerk of the Board. E. R. Smith is the County Engineer.

OFFICIAL DOPE SHEET

Information About Lateral Highway Number 2, Walla Walla County, Washington.

CALL FOR BIDS. At 11 A. M. Friday, March 20, the Board of County Commissioners of Walla Walla County will open bids on a contract to grade and surface with two-course crushed rock 4.05 miles of Lateral Highway No. 2 known as the Touchet River Road. The proposed highway begins at a point on State Road No. 3 in Touchet, Washington, and runs northerly through an irrigated and wheat country a distance of four miles. Touchet is a shipping point on the Union Pacific sixteen miles west of Walla Walla.



CLASSIFICATION. Test pits were used to classify materials. Except for the removal of a few yards existing surfacing all Class "A" and Class "D" excavation is common. Soil is a volcanic ash, light, dry, and sandy in character. Cross sections were taken every twenty-five feet.

ABOUT ROCK. There is a free quarry site at the north end of the work. Rock is "dice" basalt. Subgrade is to be rolled when moist. The base course is three-inch minus crusher run. The top course is one-inch minus. The base, binder, top, and dressing courses are to be bladed, dragged and rolled.

CONCRETE. The concrete listed is in seven cattle passes each containing twenty-five yards and in siphon headers.

SLOPES. All earth slopes are to be one to one except in the two largest cuts where one-half to one is specified. These steeper slopes are to be sprinkled with fuel oil to prevent erosion. Slopes and dumps must present a smooth, even appearance.

DATE OF COMPLETION. Proposals will be received based upon three dates of completion, namely, July 1, August 1, and October 1. The early date will be favored. Plans were approved by the Washington State Highway Department February 21, and the call for bids officially advertised in the Waitsburg Times of February 27, March 6, and March 13. Specifications are Washington State Standard.

PRICES. Local dealers quote the following prices: Sand $1.95, Gravel $2.12, Cement $3.96, Fuel Oil 4c f. o. b. cars at Touchet. For concrete pipe in place: 12" $1.22, 18" $1.80, 24" $2.65, 36" $4.95, 48" $7.55. Masonite 8c per sq. ft.

QUANTITIES. The larger quantities include:

Standard Catch Basin	1 only	Crushed Stone Base	2,432 cu. yds.
Excavation, Class "A"	73,155 cu. yds.	Crushed Stone Top	2,400 cu. yds.
Excavation, Class "D"	2,400 cu. yds.	12" Reinforced Concrete Pipe	1,001 lin. ft.
Excavation, Solid Rock	530 cu. yds.	18" Reinforced Concrete Pipe	201 lin. ft.
Excavation, Structure	1,430 cu. yds.	24" Reinforced Concrete Pipe	117 lin. ft.
Overhaul yard stations	120,330 cu. yds.	36" Reinforced Concrete Pipe	8 lin. ft.
Concrete Class "A"	77 cu. yds.	48" Reinforced Concrete Pipe	196 lin. ft.
Concrete Class "B"	136.5 yds.	Fuel Oil	7000 gals.
Steel Reinforcing Bars	15,060 lbs.		

PLANS ARE ON FILE in the office of County Engineer, Walla Walla, and at the offices of the Associated General Contractors, Spokane, Portland, and Seattle, and Pacific Builder and Engineer, Seattle. A deposit of $5.00 is required to insure the safe return of the plans on or before the time of opening of bids.

THE BOARD of County Commissioners of Walla Walla County is made up of H. J. Copeland, Walla Walla, Chairman; C. E. Cummins, Touchet; and C. N. Eaton, Waitsburg. A. C. Moore is Clerk of the Board. E. R. Smith is the County Engineer.

Contract Data and Site of Job

Given By Walla Walla Dope Sheet

By EDWARD R. SMITH*

A.B.C.E., Walla Walla County Engineer

WHEN a contractor hears of a project advertised for bids he wants to know where it is, the kind of work to be done, the size of the project, the quantities of material and work required, the cost of materials used, the date of completion and the methods of payment, the officials in charge of the work, and if attractive, where he may obtain plans and specifications. These questions are answered in a circular called an "Official Dope Sheet" distributed by Walla Walla County, Washington, three weeks before the letting of a road or bridge contract. All contractors, construction publications, and builders' associations within bidding distance of Walla Walla County receive one of these sheets which gives approximate quantities, dealers' prices of materials, date of completion, and important data concerning the proposed project. There is printed in one corner of the circular a sketch of the proposed structure or a vicinity map of the road to be built. In order that this information be at all valuable to the prospective bidder, the quantities involved must be very approximately correct and precautions taken in checking volumes and weights. The contracting profession of the Northwest is entirely in favor of this method of distributing condensed advance "dope." Recently the Portland (Oregon) Bridge Company said of these sheets: "Your manner of presenting the matter may not be entirely in accordance with some engineer's ethics, but from a contractor's viewpoint I can say without hesitancy that you include more real information in your little official dope sheet than is usually presented by the average engineer with an entire set of blue prints and a voluminous set of specifications." Gumaer and Straalund, contractors, write:

"Your courage in bringing to the contracting element something of real value, which something lies beyond the ability and ethics of engineers in general, is indeed

*Member Washington State Association of County Engineers, Member Northwest Society of Highway Engineers, Member Fourth U. S. Engineer Association.

a valuable step forward in a field avoided by those with less courage than yourself."

In return for our efforts to place in the hands of the contractor a large amount of reliable, but abbreviated, information, we not only stimulate interest in county projects but we supply plans, blue prints, and specifications to only those contractors who actually bid. Before the opening of bids on a road project, 200 dope sheets were mailed to contractors, 22 sets of plans were given out, and there were 20 bids. Dope sheets about a bridge project were mailed to 100 contractors, 10 asked for plans, and of this number 9 turned in bids.

If the work does not appear attractive to the man reading the dope sheet he is not led on a long trip with loss of time and money by the lure of possible profits. The work of a few minutes with paper and pencil tells him whether or not he has a chance to get the work. If he does look the work over the map helps him find the place and indicates important features of the work. The listing of prices saves time for both dealer and contractor.

To our knowledge this method of giving information about work to contractors has not been used by other counties.

Looking Ahead in Bridging Small Streams

By JAMES D. SAUNDERS
Engineer, Evansville, Indiana

THERE are 130 miles of paved streets in Evansville, Indiana. This mileage is being added to constantly as funds for this purpose become available. The improvement of streets often requires the replacement of small bridges over small streams. In some portions of the city, these streams present no particular problem. In other sections they are offensive and occupy room that could be well placed to other uses.

This is particularly true of Granger Ditch which is located in the eastern portion of the city. In addition to storm water, this stream carries some household sewage. For this reason it is offensive and doubly so that it passes through some of the best residential sections of the town. As could be expected in a city that takes pride in its appearance, abutting property owners

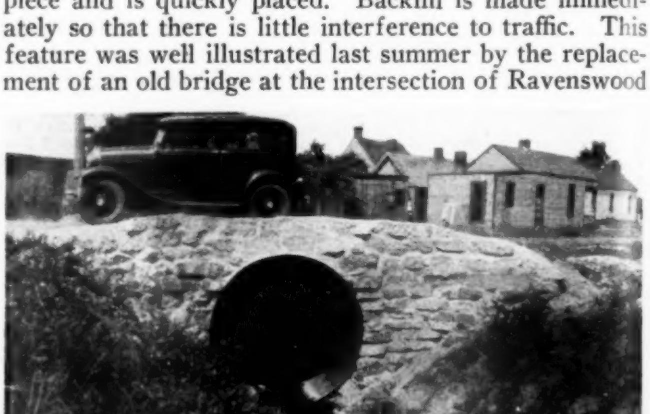
The old bridge, too narrow to carry traffic on the improved street

Placing pipe with aid of small power grader

are awaiting the day when its enclosure can be effected.

To date, a start has been made in this direction by using a paved invert pipe for bridge replacements that are made from time to time as streets over the ditch are improved. This product is not new to the city of Evansville as it has been used previously for sewer outlets into the Ohio River, both for the 9th Avenue sewer and a sewer under the new river-rail terminal.

Speed in placing recommends this construction for municipal uses. Pipe of this type is fabricated in one piece and is quickly placed. Backfill is made immediately so that there is little interference to traffic. This feature was well illustrated last summer by the replacement of an old bridge at the intersection of Ravenswood



The completed installation, note the full width roadway which was later paved

and Henning Avenues which was too narrow to meet the demands of traffic at this point. The removal of the old bridge was completed by 1:00 P. M. and by 11:00 A. M. the next day the pipe was in place and backfill completed to allow the passage of traffic. Later this installation was paved over.

The old concrete from the former structure was broken up and used to build rubble headwalls at the end of the pipe installation. This type of headwall proved very satisfactory and effected a big saving. Similar installations were made at Taylor and Lodge Avenue, and Rotherwood Drive.

By using care in the selection of its drainage structures Evansville not only is taking care of its present needs but is looking into the future, when they hope to cash in on their present investment by designing present structures to fit in with further improvements.

These improvements were directed by the Department of Public Works and the work was under the direct supervision of the writer.

Class 5 Roads in New Hampshire

Travelers Would Choose to Travel Secondary Roads If Improved

By N. M. Flagg
Secretary, New Hampshire Farm Bureau Federation

IT HAS long been recognized in our state that the burden of maintaining its town roads was altoher too heavy to be borne by the local taxpayers in many cases. This was particularly true in those towns where there was a large mileage of roads and a small amount of taxable property upon which to levy the taxes.

There was no opportunity under the existing laws to secure any aid from the state on these roads, and in 1922 the State Farm Bureau began urging the adoption of a gasoline tax, in the hope that, out of new revenue secured from this source, some help might be had. The gas tax was new in those days, being in operation in only a few instances throughout the nation. However, as a result of vigorous action on the part of the Farm Bureau, a tax of one cent per gallon was placed on all gasoline which was used in automotive vehicles travelling the highways of the state. This action was taken by the legislature of 1923 and resulted in a very substantial revenue to the state, but it was specified that this money should be expended on the trunk lines.

A joint committee of the State Grange and the State Farm Bureau was formed soon after this and after exhaustive studies as to valuation, road mileage, and tax rates in all of our towns, the so-called Duncan Road Bill was drafted and introduced into the 1925 legislature. In spite of rather vigorous opposition the bill was passed.

The provisions were, that, if a town, after raising fifty cents for each one hundred dollars of its valuation, for use on town roads, did not have an amount equal to eighty dollars for each mile of such roads, it should receive, out of the gas tax income, a sum sufficient to make this amount of eighty dollars per mile available for this purpose.

For example, if a town's valuation was seven hundred and fifty thousand dollars, it would be required to raise thirty-seven hundred and fifty dollars to qualify for aid (fifty cents on each one hundred dollars). Then, if this town had eighty miles of Class 5 or town roads, the amount raised locally would equal only $46.875 per mile for these roads, and it could receive from the gas tax income the difference between this amount ($46.875) and the eighty dollars per mile, as provided for, or $33.125 per mile, or a total of two thousend five hundred and fifty dollars. This is not an extreme case, as figures given later will show.

The figure of eighty dollars per mile was used because that was approximately one-half the amount formerly expended, on the average, by many towns. The fifty cents per one hundred dollars of valuation was used because most towns had been in the habit of raising that amount, or more, and it was not thought wise to force a town to increase its expenditures for the purpose of securing help on this problem.

So apparent were the benefits from this new law and so fair was its operation that two years later it was amended so that a town had to raise only forty-five cents on each hundred dollars in order to qualify for aid.

This did not look like much of an improvement at first glance, but to use the same town as before for purposes of illustration, we find the following:

Valuation, $750,000.

Raised locally, $3,375 (45c per $100).

This equals per mile, $42,1875 (for 80 miles).

Received from gas tax, $37.8125 per mile, or a total aid of $3,015. With this change, this town, by raising three hundred and seventy-five dollars less, received aid to the extent of four hundred and sixty-five dollars more.

Under the original bill nearly sixty towns received a total of $61,318.03 in 1926. Under the amended bill, in 1928 there were about seventy towns that received a total of $83,425.07.

In the meantime, the revenue from the gas tax had increased tremendously, both through increased use of gasoline and through an increase in the tax rate, which started at one cent per gallon in 1923, was increased to two cents in 1924 and raised to three cents in 1927.

At the special session of the legislature in 1927, still another cent was added, but the income from this last one cent increase is being used to retire certain "Flood" bonds. which were issued as a result of the disastrous flood damages in 1927, and upon their retirement, this additional one cent tax is to continue to be used in retiring another small bond issue which became necessary.

With the tremendous increase in revenue from this source, it was felt by many that the plan of helping the over-burdened towns, as operating through the Duncan law, might well be extended and at the 1931 session of the legislature a second amendment to the bill was introduced and passed, becoming effective at once.

So, at this time, the situation now is, that when a town raises forty cents per hundred dollars, and this sum fails to provide *ninety* dollars for each mile of Class 5 roads, it shall receive enough from the state to make ninety dollars per mile available.

To use our illustration once more we now have this picture.

Valuation, $750,000.

Raised locally, $3,000 (40c per $100).

This equals $37.50 (80 miles).

Received from gas tax, $52.50 per mile, or a total aid of $4,200.

Of course this means several things. For one thing, it means that the towns with a low valuation and the large road mileage are receiving substantial help.

It also means that, without this help these same

towns would either have to neglect their roads or else run their already high tax rate very much higher yet.

It has also meant much to some towns from the very practical point of view of providing employment, for, the heaviest item of expense in the maintenance of dirt roads is labor, and those towns which receive two, three, or even as high as five thousand dollars per year for this purpose are certainly helped in many different ways.

Many of our farms are once more desirable with the advent of better roads, and many an old farm, which seemed destined to go back to the wilderness from which it was carved has been sought for a summer home as a result of the modern combination of rubber tires and better roads.

The justice of this law is now acknowledged by nearly all, and already there is being launched, a movement to further amend it so that the benefits to the towns may be increased.

During 1931 the following towns were helped in the amounts given:

We feel that, with the universal use of the automobile and its attendant fact that every car owner has to pay in proportion as he uses the roads, through the gas tax, some reasonable portion of the funds derived from this source should go back to the rural towns for use on town roads, rather than to be used entirely, as at first, on the main arteries of travel.

We believe that during the tourist season, when traffic is at its heaviest, a very considerable number of drivers would, from choice, use our secondary and town roads, if they were in reasonably good condition.

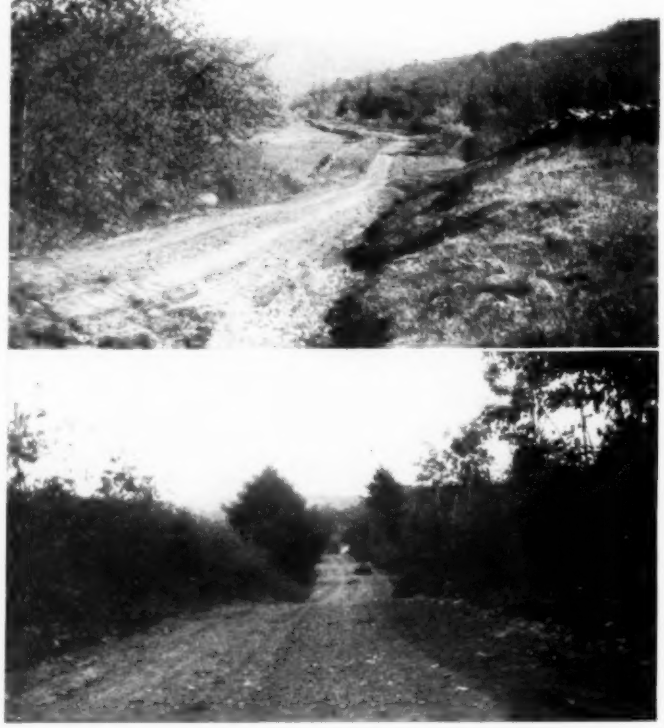
We also believe that this would take place to such an extent that it would be a factor in helping to relieve the congestion on our trunk lines.

With the population either stationary or diminishing in many of our back towns and with a decreasing number of active and occupied homes and farms from which to secure tax revenue, it would seem to be the part of wisdom for a substantial diversion of the gas tax revenue to these towns.

The intelligent use of this money, by the towns, will continue to be an all important influence in the restoration of many of our beautiful hill towns.

Acworth	$4,612.14
Alexandria	1,172.20
Alstead	2,087.00
Andover	114.40
Amherst	1,789.61
Auburn	1,093.65
Barnstead	4,527.10
Barrington	3,333.87
Bath	58.27
Belmont	813.20
Bradford	2,351.51
Brentwood	117.48
Brookfield	597.85
Canaan	4,457.67
Candia	1,702.30
Canterbury	2,152.40
Chester	1,266.30
Chichester	1,293.11
Cornish	1,704.06
Croydon	389.73
Dalton	1,913.66
Danbury	3,589.40
Deerfield	3,648.07
Deering	3,074.71
Dorchester	1,163.39
Dunbarton	2,060.43
Eaton	1,267.93
Effingham	2,503.97
Fitzwilliam	1,522.60
Francestown	2,072.28
Freedom	1,146.80
Gilmanton	4,355.49
Gilsum	374.40
Goshen	826.03
Grafton	1,925.98
Greenfield	1,747.39
Hancock	1,939.60
Henniker	1,535.60
Hill	382.60
Hopkinton	1,212.45
Kensington	39.85
Landaff	571.10
Langdon	1,641.16
Lee	1,758.88
Lempster	2,049.33
Lyme	332.07
Loudon	3,008.30
Lyman	1,738.91
Lyndeboro	2,645.60
Madbury	492.18
Madison	325.60
Marlow	1,133.05
Mason	2,399.04
Middleton	950.44
Mont Vernon	1,390.35
New Boston	4,788.24
New Ipswich	1,485.20
New Durham	2,234.20
Nottingham	1,957.90
Orange	332.24
Pelham	277.17
Plainfield	3,124.22
Richmond	2,155.19
Roxbury	1,074.60
Salisbury	1,141.60
Sanbornton	998.00
Sandown	1,486.95
Sandwich	736.33
Sharon	833.99
Springfield	1,960.21
Stoddard	475.20
Strafford	2,961.90
Sullivan	1,351.60
Sutton	2,845.70
Tamworth	448.79
Temple	2,158.60
Warner	1,851.80
Washington	1,330.00
Weare	5,018.83
Webster	1,026.36
Westmoreland	1,831.41
Wilmot	1,967.08
	$142,225.80

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement



Typical Class 5 Roads in New Hampshire

Appeal for Road Improvement

Morganfield, Kentucky.—If I were going to send any message from this office it would be in the form of an appeal for road improvement. The concentration of funds for primary roads is working havoc on rural routes. My roads have been without work for two years, except for private contributions. With the primary road program developed to its present point, rural route roads should share liberally in road appropriations hereafter. I believe road oiling would be the best, quickest and most economical solution to the secondary road problem in most cases. A road improvement program of too expensive a type would leave most of us in the mud the rest of our lives.

Speaking of mud and mire, I would just like to say that those who have not experienced it first hand knows nothing of what it means to a rural carrier in terms of work, worry and expense.

Early improvement of these conditions would mean much to the public in general and go far toward aiding the unemployed. Kindest regards.

Yours,

Ross Buchanan.

From the *National Rural Letter Carrier*.

Variable Definitions of Highway Terms

Subcommittee on Accounting to the Committee on Administration Rendered Tentative Report to the American Association of State Highway Officials on Many Other Terms

IN actual highway practice little progress has been made toward developing and using as general standards concise definitions of such terms as construction, maintenance, reconstruction, widening, and administration, or to set up a list of subordinate operations under each heading which not only renders an accurate accounting of funds expended but also provides for the issuance of data covering costs of operations and units of work performed. Definitions explaining uniform conceptions of highway operations is the basis upon which the accounting and administrative structures must rest. A well-designed and organized system of accounts is indispensable to the proper and efficient management of any highway department. Uniform systems of accounts in use throughout the highway departments of the various political subdivisions of the United States would make comparisons possible which would lead to still more effective management and uniformity in ways and means of doing work.

In order to make such information comparable, it will be necessary to obtain standardized definitions for a large number of engineering and accounting terms. Following are replies which answer the questions in last month's issue:

▼

Maintenance.—To preserve or keep in a state or condition which will conform as near as possible to the general features of its original condition without adding to or making replacements other than those necessary to a limited extent to preserve such condition.

Construction.—To build or create something which is entirely new and is not merely bettering or replacing something of a similar nature which existed there before. It must be admitted, however, that construction is a broad term and in some cases merges insensibly with the term of reconstruction. It is different to draw a fine and definite line of distinction, especially where an old narrow pavement is widened and rebuilt into a broad thoroughfare but at the same time some salvage value is given to what formerly existed there. In such cases the conditions are so changed from the original that a part of the work might be called construction and a part reconstruction, the term to be used depending on which involved the most work. Either term might apply although a strict interpretation of the word "construction" I believe would limit such to the original definition, meaning something entirely new.

Reconstruction.—To improve something which has existed either by total replacement or by adding to in such a manner that it has the appearance and features of something entirely new.

Widening.—When classed by itself, it merely adds to the width of an existing improvement with either the same or a different type of material but does not replace or change the condition of the original part of the improvement. In case an existing improvement is replaced or changed by covering up or resurfacing and further improving in connection therewith by adding to the existing width, by constructing something new along the side or sides so as to result in a greater width and an entirely new surface, the improvement should be classed as reconstruction and widening.

There are undoubtedly some differences of opinion as to the definitions of the above terms; I am sure that in some cases the laws of the different states have something to do with forming the definitions as applied to the work in the respective states. This is due to the fact that certain funds may be used to do different classes of work coming within the meaning of the above terms, consequently there are times when it may be convenient to apply rather liberal meaning to such terms in order to cut some of the red tape wound around highway finances. As applied to work in Ohio I believe my definitions outlined could be applied in practically all cases. There are cases, however, when as I noted above, the terms merge and it is difficult to draw a definite line of distinction.—*H. G. Sours, County Engineer, Summit County, Akron, Ohio.*

▼

Maintenance.—Repair work necessary to render a road or pavement in good condition for travel and approximately equal to its original construction.

The term "maintenance" as used in highway operations has no fixed and certain meaning that is the same in all sections of the country. Generally speaking, maintenance means to preserve something in its original condition. In some states all forms of maintenance, repairs, resurfacing, reconstruction, and even widening are classified as maintenance—frequently in order that they may be eligible to receive a certain class of appropriated funds. In the case of private industry, such as a railroad, any expenditure on reconstruction that is greater than that to "renew in kind" is classed as an addition and betterment charge and a strict accounting kept of the same. This addition and betterment account permits the company to increase its credit and borrowing powers. In public work there is not the necessity for a rigid distinction between maintenance and betterments.

Reconstruction.—Replacement of the original pavement in kind or additions and betterments to its original condition. Other terms involved would be resurfacing and replacement.

Construction.—The building of any kind of surfacing or pavement in addition to the existing earth road or grade. The term is also used in connection with the grading of a new highway or street.

Widening.—Increasing the width of an existing road or pavement.—*G. F. Schlesinger, Chief Engineer & Managing Director, National Paving Brick Association, Washington, D. C.*

The Mississippi Valley Association of State Highway Officials at one time agreed that any work which tended to restore a road to a condition in which it previously had been should be considered maintenance, and any work which tended to widen or increase the depth of the wearing surface of the road should be considered as a betterment even though said work might be paid for from maintenance funds.

I do not believe there should be any particular distinction between construction and reconstruction. It occurs to me that any work on a road which changes it to a higher type road should be considered construction; for example, an ungraded earth road is constructed when it is built to grade. An unsurfaced earth road is constructed when it is surfaced with gravel. A graveled road is constructed when it is resurfaced with blacktop, concrete, or brick pavement. The word reconstruction simply means that construction money has previously been expended on the road in question; for example, an ungraded earth road might be graded as a construction job and several years later when this road is to be paved it might be necessary to do considerable additional grading. Some parts of the old road may be relocated, the fills may be widened and the road in general brought to a higher standard. This is sometimes called reconstruction but to all intent and purposes, in my mind, it is construction work.

In answer to your fourth question, I would say that widening should be classed as construction. It raises the road to a higher class than it formerly was. I realize that considerable widening is sometimes done and paid for from maintenance funds but such expenditures should always be kept separate from general maintenance and classified as maintenance betterments, which after all are simply construction operations which for convenience are paid from the maintenance fund.—*W. H. Root, Maintenance Engineer, Iowa Highway Commission, Ames, Iowa.*

▾

Maintenance is the process of applying labor, (directly or through the use of tools or equipment) or labor and materials to a utility (herein considered as a highway or some unit of a highway) to continue the normal serviceability of the utility, the cost of which (labor and material) does not in general exceed twenty-five per cent of the replacement cost of the utility.

Reconstruction is the process of applying labor directly or through the use of tools or equipment, and additional materials to restore a worn out or nearly worn out utility to approximately its original condition of serviceability, the cost of which in general will exceed twenty-five per cent of the replacement cost of the utility.

Construction is the process of applying labor to materials to form a new or replacement utility.

Widening as applied to highways is construction or reeconstruction which adds to the effective width of a highway, right-of-way, grade, surface, culvert, bridge or other unit which carries vehicular traffic.—*H. S. Carter, Professor of Civil Engineering, South Dakota State College, Brookings, S. D.*

▾

In conjunction with "construction," I always like the word "build" and if you will pause a while and consider it, I think you will agree with me.

Therefore, I am going to make my definition of each of the words as short and clear as I think is possible.

Construction.—Building.

Maintenance.—To keep that built, as nearly as possible, in its original condition.

Reconstruction.—To rebuild or improve that already built.

Widening.—To increase the usable area of that already built.

In conclusion, don't let any of us, Engineers, Contractors, Commissioners or Editors, forget those wonderful words of John Ruskin:

"Therefore, when we build, let us think that we build forever. Let it not be for present delight, nor for present use alone. Let it be such work as our descendants will thank us for, and let us think as we lay stone on stone that a time is to come when those stones will be held sacred because our hands have touched them, and that men will say as they look upon the labor and the wrought substance of them, 'See! This our fathers did for us.'"—*F. J. Murray, Asphalt Division, Shell Petroleum Corporation, Chicago, Ill.*

▾

My definitions are as follows:

Construction.—This term is applied to an operation which results in an entirely new piece of work.

Maintenance.—This term is applied to an operation the object of which is to restore a piece of work to a state of efficiency or a condition equal to that which it had immediately after its original completion.

Reconstruction.—This term is applied to an operation in which an existing piece of work is salvaged and incorporated into the finished product.

Widening.—This term is applied to an operation in which a piece of work, which except as to width is entirely acceptable, is made wider.—*Edmund Meslor, 41 Northmoor Place, Columbus, Ohio.*

▾

Your questions as to the proper definitions for construction, maintenance, reconstruction, and widening covers a lot of ground, but the following definitions are offered as a start:

Construction.—The building of any road from the subgrade up, or even including the subgrade.

Maintenance.—The operation of keeping a road surface as close to, or in slightly better than its original condition.

Reconstruction.—The rebuilding, or resurfacing, of an old road by the addition of new aggregate, in order to strengthen the road surface.

Widening.—The construction of additional widths of surface.—*A. R. Taylor, Tarmac Department, Koppers Products Co., Pittsburgh, Pa.*

▾

W. H. Connell, when he was acting secretary of highways and engineeering executive of the Pennsylvania Highway Department, covered the subject as follows in the 1927 Proceedings of the American Road Builders' Association, page 224:

Highway maintenance "covers all work and costs necessary to provide for the upkeep of the highway system, including overhead costs. This means, not only keeping the pavement in smooth and proper condition for travel, but also such costs as are chargeable to making all the necessary provisions for highway transportation, such as snow removal, painting traffic lines, etc., and while new signs, signals and reflectors might technically be a construction charge, in this discussion we shall assume that they are included in the maintenance and operating expenditures for the upkeep of the highway system.

"The replacement of pavements with like pavements is strictly a maintenance charge, but replacement with a better and more expensive type is part maintenance and part capital charge, or all of the cost over and above

what would be required to replace the original pavement or structure with a like structure is properly a capital charge. . . . Betterments and additions such as new paving, widening existing pavements or building of any new structures, of course, are capital charges."

This analysis of the matter seems very clear to me and by applying these rules regarding capital charges and maintenance charges, it will always be possible to determine what any particular operation may really be. For example, the resurfacing of a concrete road would be a capital charge since it adds to the traffic capacity of the road. A widening operation would likewise be a capital charge.—*M. D. Catton, Highways and Municipal Bureau, Portland Cement Association, Chicago, Ill.*

When you come to try to make detailed definitions for these words you find that they are complicated by the practices in administration and accounting in the various jurisdictions, so probably, in each jurisdiction the definition would be an arbitrary one based upon their own practice. It is just this condition that should be corrected. One reply states as follows:

Maintenance includes all of the routine upkeep of the roadway surface and all its appurtenances, and the operations are performed from time to time throughout the year.

Reconstruction is the periodic rebuilding of a road surface into a new surface of substantially the same general character. The distinction between reconstruction and construction is not sharply drawn as these terms are ordinarily used.

Construction is the work of building highway facilities of a type or character entirely different from anything that exists. However, this term is widely used to include operations that are a part of maintenance or a part of reconstruction.

A strict interpretation of the term *widening* would require that it be classed as construction.—*To the Editor.*

The following is taken from the *Report of the Subcommittee on Accounting to the Committee on Administration of the American Association of State Highway Officials:*

Highway construction may be said to be divided into two classes:

1. *New construction* which consists of the work as originally built and includes the finished road with all its structures and facilities. The cost of such new construction should include any temporary structures, conveniences or detours, which may be provided while such construction is in progress.

2. *Additions and Betterments* which consist of the following:

a. Addition of new structures or facilities.

b. The improvement or betterment of existing structures or facilities.

Examples of this work are as follows:

1. Replacement of lower type with higher type of construction, such as the surfacing of an earth roadway with gravel, macadam, cinders, shale, etc.

2. The widening or lengthening of surfaces or pavements, including curves, either with the same type of construction or with any other type of surfacing or paving.

3. Construction or erection of new structures which were not deemed necessary when the road was originally designed or constructed, such as baffle walls, retaining walls, tile lines, safety and direction signs and devices.

4. Construction or completion of gaps in the surfacing or pavement, regardless of the type of surfacing used in the completion or construction of the gap.

5. The addition of extra width, length, depth or height to existing structures or facilities, such as the following:

1. Lengthening of wing walls.
2. Lengthening or widening of culverts.
3. Extension of headwalls.
4. Extension of guard fence.
5. The enlargement or improvement of other highway facilities, such as deepening and widening of ditches; widening of shoulders; reducing grades; changing or straightening stream channels, etc.

Additions and Betterments Should Not Be Confused with Extraordinary Maintenance

Additions and Betterments are always of an improvement nature, whereas Extraordinary Maintenance is always of a repair or a reconstruction nature, even though the structure or facility may be slightly improved by such repair or reconstruction. The following examples show the distinction between Additions and Betterments and Extraordinary Maintenance.

1. The work done in restoring shoulders, slopes or subgrade in the case of damage done by flood or washes to a road which is located along the edge of a river or stream should be considered as Extraordinary Maintenance, whereas, if a slope wall were built or riprapping were placed to prevent such wash or undermining, such work would be of an improvement nature and should be considered as Additions and Betterments.

2. The work done in restoring a retaining wall which has been entirely or partiallv carried away by a slide, even though it were slightly strengthened, lengthened or improved when rebuilt, would be considered of an extraordinary Maintenance nature, whereas, if the work resulted in a wall of a decidedly improved design, or if any appreciable length, width or height were added, then such work would be of an improvement nature and should be classed as Additions and Betterments.

Highway maintenance is the function of repairing, replacing, reclaiming, restoring, renewing, reconstructing, preserving and keeping each type of roadway, structure and facilities as nearly as possible in their original condition as constructed or as subsequently improved.

The work of maintaining these types consists of the repair, replacement, resurfacing or reconstruction of the pavement slab or surface; painting traffic lines; filling cracks and joints in the pavement slab; filling ruts and erosion in shoulders, fills, slopes and cuts; repairing and cleaning culverts, ditches and drains; cutting weeds and vegetation; cleaning and clearing the right-of-way; repainting and replacing route markers and safety signs; repairing and repainting guard fence; repairing, repainting, cleaning and reconstruction of bridges; removal of snow, care of trees, shrubs and plants; operation and maintenance of highway utilities; and providing detours and temporary structures while the work is in progress.

Any work on the roadway, structure or facilities which tends to make them stronger or safer, or more adequate to the traffic or the purpose which they serve, such as changes in type of roadway or the appreciable addition of extra width, length, depth or height, should not be classed as Special or Emergency Maintenance but should be classed as Additions and Betterments.

Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

BEFORE

Above—When the surface of this township road in Somerset County, New Jersey, made butter out of the farmers' milk before they could get it to a dairy—

Right—Why Township Superintendent Robert Burton wanted to work on this traffic barrier is not hard to understand. It looks like "No Man's Land" between the Japanese and Chinese forces.

AFTER

Above—Raritan Township officials decided the time had come to smooth up this dirt road which had become filled with a fine grade of crushed stone.

Left—Willoughby Township, Lake County, Ohio, was well satisfied with the transformation wrought by Mr. Burton. The oversize stone, in finishing, was raked off the surface.

The Road Builders' News

County Highway Officials Meet in Atlanta

A sectional meeting of county highway officials including all the South-Atlantic states will be held under the joint auspices of the County Highway Officials Division of the American Road Builders' Association and the Association of County Commissioners of Georgia at the Ansley Hotel, Atlanta, Georgia, on May 17, 18 and 19.

"County highway officials from all surrounding states are cordially invited to attend this meeting called to discuss the special problems of the counties of the South-Atlantic states," states Chas. E. Grubb, engineer executive of the County Highway Officials' Division of the American Road Builders' Association. "The program will include addresses by representative county officials from all sections of the South."

The County Commissioners' Association of Georgia meeting usually assembles 500 officials. The association has for its object the development of a system of paved highways connecting every county seat and every important town in Georgia. Officers of the association include G. B. Baggs, Camilla, president; J. F. Pittman, Thomasville, chairman of the executive committee; and Fred Houser, Atlanta, secretary-treasurer.

National County Highway Program Outlined

The trend of administration and finance in county highway work was outlined by Chas. E. Grubb, Engineer Executive of the American Road Builders' Association, before the 53rd Annual Meeting of the Ohio Engineering Society, Feb. 9-11, in Columbus, O. This was a joint meeting, preceding discussion of special subjects by sessions, addresses were also delivered by Governor George White of Ohio, C. J. Brown, Secretary of State of Ohio, O. W. Merrill, State Director of Highways, and F. E. Swineford, Chief Engineer of the Ohio Crushed Stone Association.

Ralph G. Taylor, Warren, O., is president of the society and John Laylin, Columbus, Ohio, is secretary-treasurer. The meeting was attended by about 300.

A report of the American Road Builders' Association Convention at Detroit was made by H. G. Sours, County Engineer, Summit County, Ohio.

Mr. Grubb quoted W. M. Connelly, President, Michigan Good Roads Association, who said in a recent address that county conditions needed a housecleaning. County officials themselves should take stock and determine what is needed to put their house in order, and then do it, even if it stings to the quick. If they do not do it, other states will follow the lead of North Carolina, which has taken the radical step of centralizing all highway affairs in the state highway commission.

"Efforts of a state-wide character already launched in a number of states aim to correct existing defects in order to assure progress in the improvement of secondary or local roads in a satisfactory and economical manner," Mr. Grubb declared. The part counties will play in future highway development depends to a very large degree upon the manner in which counties meet present responsibilities.

Truck Executives Pleased With Road Show Meeting

The Truck Association Executives of America which met in connection with the 29th Annual Convention and Road Show in Detroit at the 7th meeting on Jan. 11 passed the following resolution:

"In appreciation of the splendid cooperation in preparation of the meeting a vote of thanks is tendered the American Road Builders' Association."

Fourteen state associations of motor truck operators and executives were represented at the meeting. Plans were made for forming a national association of motor freight people.

"I have had a great many favorable comments upon the theory of meeting in conjunction with the American Road Builders' Association, and quite a number of communications have been received from members asking that we meet again with the Road Builders' next year," states Tom Snyder, secretary-treasurer of the Truck Association Executives of America.

Highways Are Necessities

Public roads have created a vast subsidy to agriculture, industry, and to other forms of transportation in that without highways the wheels of business would cease to turn stated H. S. Shertz, in a report to the American Road Builders' Association in Detroit.

"No other medium of transportation has been developed which does not depend on the highway for its building or continuation," Mr. Shertz explained. "Waterways serve those on the shores, railroads aid people at sidings along the route, airplanes reach only their landing fields. Improved highways fully equipped with motor vehicles connect passenger and freight stations with vast territories inaccessible in the days when the horse furnished the power on the highways. From the raw material to the manufacturer, to the distributor, to the retailer, to the consumer the highway plays an indispensible part.

"New industries and more widespread use of commodities developed as a result of highway improvement have increased tremendously the freight tonnage of other transportation agencies. The highways have persisted because of the service rendered to the public, and their usefulness has been multiplied many fold through the development of motor vehicles.

"The highway needs no defender for it has a legion of friends. Whether in war, as Roman roads still existing bear mute testimony, or in the peaceful pursuits of the post roads, recognized in the Federal Constitution, the highway has served well. Improvements in vehicles have been followed by betterments in highways to make best use of the new vehicles.

"Without highways other methods of transportation would be paralyzed," he declared.

"The greatest usefulness of the highway lies in public control by highway uses rather than by agencies that wish highways regulated so that private profits may be increased. Since the earliest historic times the highway has been serenely useful, interwoven with daily life."

Public Should Aid in Street Car Track Paving

Paving in street railway tracks is not so much a matter of the improvement possible in construction as it is a question of where the street railway companies are to obtain the funds to make the changes, repairs and renewals shown desirable through research developments according to Harry Shaner, commissioner of public works, Winston-Salem, N. C., in a report to the American Road Builders' Association.

"A reasonable portion of the funds set aside by cities for street work should be used in the pavement of street railway tracks," declared Mr. Shaner. "The street car rider should not continue to pay such a large share of the cost of pavements that are laid primarily for the benefit of users of other forms of transportation."

Making the Earth Solid Under Roads

Everyone knows that a solid foundation is necessary for a road that will not sink or subside. Highway engineers draw a sharp line between settlement and subsidence. Settlement is held to be the reduction in depth of an earth embankment caused either artifically or by the elements and time; subsidence is the result of the sinking of the embankment into the soil on which it rests. These and other fine distinctions that lead to making earth embankments more stable were contained in a joint report of the American Road Builders' Association and the Highway Research Board presented at the 29th Annual Convention and Road Show in Detroit.

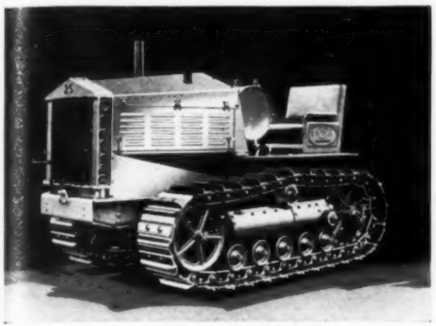
Various types of equipment are used to compact embankment.

New Equipment and Materials

New Tractor

A new Cletrac 25 has been brought out by the Cleveland Tractor Co., Cleveland, O. The tractor is equipped with a Hercules 6-cylinder motor and electric starting and battery ignition as standard equipment.

The tractor has a length over all of 105 in., and a width overall of 57⅜ in. The height at radiator cap is 55¼ in. The clearance is 13½ in. The width center to



New Cletrac 25

center of tracks is 42 in. The weight is 6,725 lb.

The tractor has a turning radius of 8½ ft. The drawbar horsepower is 27 and the belt horsepower is 35. The track wheels consist of one upper and five lower plain bearing track wheel assemblies on each side with continuous positive lubrication through felt wicking. The tracks have 58 forged steel, 12 in. track shoes with interchangeable grousers; 11/16 in. track pins. All pins, rollers and bushings are carburized and hardened. The length on the ground, each side, is 62¾ in., and the total tractive surface is 1,506 sq. in.

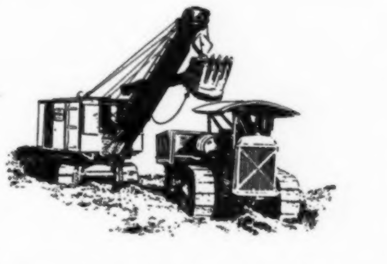
The transmission and speeds are as follows: Selective type transmission; low speed 1.95 m.p.h.; intermediate 2.8 m.p.h.; high 4 m.p.h.; reverse 1.83 m.p.h.

New Welding Torch

The Alexander Milburn Co., Baltimore, Md., has placed on the market an entirely new welding torch known as the Type HMS which is their latest development in welding apparatus.

New Milburn Type HMS Welding Torch

The HMS torch is constructed of the finest materials throughout and is recommended for all types of welding. Copper, swaged welding tips are usually furnished but they may be removed from the torch



handle and replaced by extensions of various lengths.

These extensions are light, but unbreakable nickel-silver tubes utilizing Milburn standard Type FX and UB welding tips. The extensions are also interchangeable with Airco Davis-Bournonville welding torch Style 8800, etc.

New "American Gopher" Shovel-Crane-Dragline

The American Hoist & Derrick Co. of St. Paul, Minn., is offering a new model "American Gopher" shovel-crane-dragline, gasoline or diesel engine operated, in five sizes, namely, Model 375—¾-yd.; Model

New "American" Gopher Shovel-Crane

400—1 yd.; Model 425—1¼ yd.; Model 450—1½ yd. Model 475—1¾ yd., all mounted on continuous chain crawler treads, with two speeds.

All sizes are newly designed. Compactness, simplicity of design, increased strength in all wearing parts, ease and convenience of operator, levers having "fingertip" control, are some of the combined features of the new "American Gopher," in each of the new models.

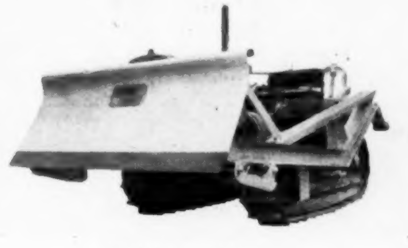
New Bulldozer

A new hydraulic high lift bulldozer has been brought out by the LaPlant-Choate Manufacturing Co., Cedar Rapids, Ia. The outstanding features claimed for it include the following:

An extra high lift which enables the blade to be raised 33 in. above the ground level.

A new type H-main frame design and high lift mechanism at the rear of the tractor, which allows the blade to drop 18 in. below the track ground line.

A double acting jack which forces the blade into the ground or raises it quickly out in the hardest going.



Hylift Bulldozers

A unit with the blade and jack built compactly to the tractor to facilitate its use in close quarters.

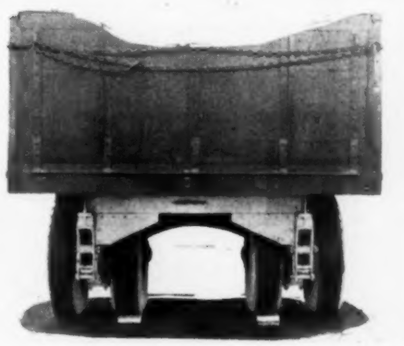
A design which leaves the tractor drawbar entirely in the clear, so that it may be used for hauling wagons or other equipment without removing the bulldozer.

A complete ground clearance when the blade is raised prevents the unit from "high-centering" on the bulldozer main frame.

New Type of Twin Axle

The Fuhrman Trailer Co., Canton, O., has perfected and applied for patents on a new type of twin axle which is claimed to make a drastic change from the old conventional type of one piece axle with dual wheels used for trailer and truck purposes.

With the new type of twin axle, two full elliptic springs are mounted one on top and one below the axle and one wheel on each side of the spring. This construction allows both wheels on each individual axle to rotate freely and if desired, brake with both wheels.



Fuhrman Twin Axle

This design is stated to allow the tires to conform to road inequalities regardless of whether the road is crowned or dished, thereby, giving the same amount of weight on each tire.

New Clam Shell Bucket

A new cleanup-rehandler bucket has been brought out by The Wellman Engineering Co., Cleveland, O. This new clam shell has scoops that cover a big area, extended corner brackets giving extra digging leverage, and a narrow and more rigid head. It also has the Williams power arms combination of lever and block and tackle. The bucket has a rigid A-frame formed G unusually rugged corner bars. Each bar is formed from a single steel billet, with the bearing integral. These are also new type extra long roller rope guards and transverse roller, the cable being protected by rollers on all sides. Roller bearings in sheaves are optional for high speed operators. They are easily interchangeable with plain sleeve bearings without any extra part. Bronze bushings are provided for all moving parts. They are readily accessible and easy to remove.

New "Champion" Cleanup Rehandler

New Concrete Breaking and Tamping Machine

A new machine for breaking concrete and for tamping trenches has just been patented by Walter Cornett, a native of California. While the patent has just been issued the machine itself has been in successful operation in Los Angeles for nearly six years and in Long Island, N. Y., and in northern New Jersey for nearly four years.

The machine is known as the rapid pavement breaker. It takes the place of the muscle tiring and slow operating hand operated pavement breakers and the drop ball. The machine is mounted on a 5-ton truck and is operated with a compressor. It is mounted on the rear end of the truck and by means of a turntable can swing from side to side and in that manner can break a strip of concrete or trench from 1 ft. wide to 11 ft. wide at the will of the operator.

The machine is stated to strike a controlled blow varying from a gentle tap to 18,000 lb. It can strike such a blow 60 times a minute. In trench work the tool is stated to a line without injury to the adjacent concrete. The machine strikes a repercussion blow.

Rapid Pavement Breaker on a New Jersey Job

By replacing the breaking tool with a tamping tool the dirt in a trench may be tamped as soon as refilled and a permanent top put on.

The National Demolition Corporation of 95 Vreeland Ave., Nutley, N. J., has the exclusive distribution of the machine nationally.

New Drill Steel Sharpener

The Gardner-Denver Co., Quincy, Ill., has increased its series of drill steel sharpeners with the introduction of the Model DS-6, a larger and more powerful sharpener.

The machine incorporates a new and distinctive scale blower operated by a small lever placed on the right hand side of the machine within easy reach of the operator. A slight movement of this handle thoroughly cleans all scale from the dies.

Equipment can be supplied for handling any size of hexagon, quarter octagon, or round steel. Double taper bits up to 3 in. on steel up to and including 1½ in. round can be forged and sharpened.

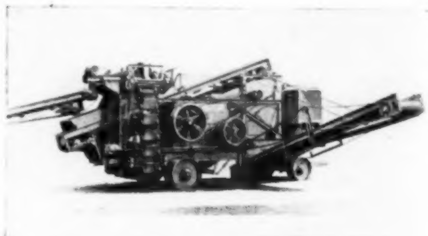
Specifications on this machine give the height overall as 48¼ in., weight 2,000 lb., and diameter of round base 28 in.

Model DS-6 Drill Steel Sharpener

New Portable Crushing and Screening Plants

To meet the growing demand for larger capacity units, capable of reducing rock and pit run gravel to small sizes, two new Western portable crushing and screening plants have been announced by The Austin-Western Road Machinery Co. The new Westeern No. 100 and No. 90 plants are stated to combine to a remarkable degree, capacity compactness, and portability. The overall height is under 12 ft.; the over all length, exclusive of the pit conveyor, is under 26 ft., and the over all width, exclusive of the delivery conveyor, is under 10 ft.

The amount of over-size in gravel pits varies greatly, and the new Western unit is therefore designed to accommodate either a single crusher or both primary and reduction crushers. The two-crusher plant is known as the No. 100, while the single crusher plant is known as the No. 90. A two-deck screen is used in the No. 100 plant and a single-deck screen in the No. 90. With the exception of the crushers and screens, the two plants are practically identical. In a pit where there is but a small percentage of over-size, the No. 90 Plant is adequate, but it always is possible to install the second crusher should the percentage of over-size increase.



New Western Portable Crushing and Screening Plant

When moving from one location to another it is only necessary to disconneect the pit and delivery conveyors. The operation is still further simplified by the fact that there is no projection below the ground level at any time. It is not necessary to dig a pit for the lower end of the delivery conveyor, and the unique bucket carrier, which returns the crushed material to the screen, also operates entirely above the ground line.

Great care was given to the selection of high grade materials. All of the moving parts from the ground wheels to the crushers themselves turn in anti-friction bearings.

The pit conveyor with its 24-in. belt delivers the material to the plant conveyor, which, in turn delivers it to the gyrating screen. Over-size passes along the screen to the crushers, or crusher, as the case may be, while the under-size drops through the screen into the 2½ yd. storage hopper, which is built into the plant. After being crushed, the over-size is conveyed to the unique bucket carrier, which surrounds one end of the plant and operates entirely above the ground line. As each loaded bucket passes over the plant conveyor it is dumped automatically.

and its contents returned to the screen where any over-size is passed again to the crushers.

Provision is made for removing excess sand or dust by placing a short section of sand screen over the upper end of the gyrating screen. The fine material drops through this section into a built-in discharge chute, which diverts it either to the ground or to a special sand removal conveyor.

Where it is desired to load the finished product directly into trucks, a 20-ft. delivery conveyor is furnished. The 2½ yd. storage hopper allows the material to accumulate while a loaded truck pulls away and an empty one takes its place. Where it is desired to load the trucks from a storage bin, a 48-ft. delivery conveyor is furnished. If but one size of finished product is wanted, a one-compartment bin is used. If more than one size of finished product is wanted, a sizing screen is mounted on the bin, and the bin itself divided into two or three compartments.

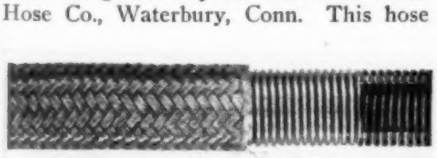
The Western No. 940 primary crusher with its 9 in. x 40 in. jaw opening, and the No. 440 reduction crusher with its 4 in. x 40 in. opening, are of the overhead eccentric type. A distinctive and exceedingly important feature of these crushers is the use of extra large SKF self-aligning roller bearings, which prevent damage to shaft and bearings from deflection.

The new Western plants may be had with a pivotal conveyor, which can be swung in a half circle around the plant. Each of the three principal conveyors—pit, plant and delivery—is operated by a very high grade clutch, and these clutches are controlled by a dual system of levers; one set at the operator's roomy platform, and a second set where they can be reached easily from the ground.

Western plants can be operated by separate power units, but are designed to accommodate self-contained units for driving the entire plant. Accessibility to all working parts is an important feature, which is well illustrated by the changing of crusher dies. To do this, it is only necessary to raise one end of the hinged plant conveyor and lift the die straight up by means of a chain block attached to the swinging davit, which is furnished with the plant.

New Flexible Metal Hose

A new type of flexible metal hose has been brought out by the American Metal Hose Co., Waterbury, Conn. This hose



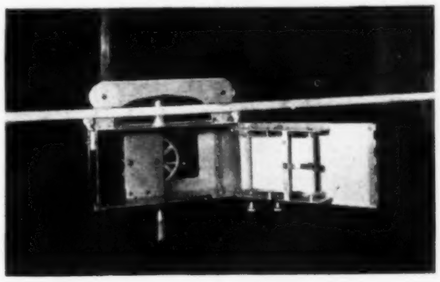
Close-Grove Wire Braided Hose

is of all metal seamless construction. It is fabricated from seamless tubing of various non-ferrous alloys as well as from steel. It is constructed without joints, seams, welds or brazes of any description. This hose is made in standard sizes ranging from $\frac{3}{16}$ in. to 2 in.

Instrument to Facilitate Plotting of Cross Sections

A new invention designed to facilitate the plotting of road sections and to record on section papers the horizontal and vertical measurements is being manufactured by Horace W. Scott, 2505 Jefferson St., Wilmington, Del.

This instrument is known as the Karto-Graf. Among the things are inventors claim it will do are the following:



The Karto-Graf

It will permit the contractor to check the engineers plotted sections and enable him to correct them before grading work is started.

It facilitates the making of final surveys. With the Karto-Graf it is a simple matter to take levels on the center line of the road, hold the track level at the designated station and run the instrument across the road. The section is thus run on paper.

The instrument will draw a section in two scales at the same time for exaggerated profiles, this being made possible by changing one or two gears, a matter of a few minutes' time.

To operate the device the contractor provides himself with a suitable support for the track on which the instrument works. With two men holding the track the instrument is placed thereon and, within a few seconds' time, the contractor has a profile of the side bank, gutter and shoulder to check against the engineer's plotted sections from which the amount of cut or fill is computed.

While the contractor is grading and shaping up the sidebank and gutters the Karto-graf enables him to do the work properly and check it while it is being done. The slightest irregularity is caught by the extremely sensitive mechanism of the Karo-graf and it quickly and accurately records the final work so that the contractor may readily see what has been done.

To check the banks of curves with the Karto-graf is easy. One merely holds the track level and the instrument will run down the slightest slope making a picture which is ready when the inside shoulder has been reached.

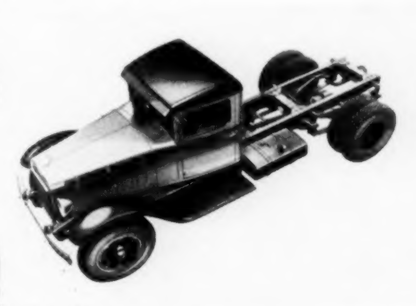
Telegraph Your Congressman to Urge Increased Federal Aid for Highway Improvement

New Heavy Duty Trucks

Two new 6-cylinder motor trucks, each with a rated capacity of 5 tons, have just been announced by International Harvester Co., Chicago, Ill. These are the Model A-7 and Model A-8 and are available in wheelbases of 160, 180, 200, and 225 in.

Engines are of the 6-cylinder valve-in-head type. Bore and stroke of the A-7 are respectively 4½ by 5½ in. and of the A-8 5 in. by 5½ in. The A-7 develops 107 brake horsepower and the A-8 132 brake horsepower at governed speeds of 1,800 r.p.m. for each unit. Removable cylinders are employed. Down-draft carburetion, fuel pump, oil-type air cleaner and thermostatically controlled cooling are other features of these power plants. The clutch is of the single-plate type, and the transmission has five speeds forward and two reverse. A power take-off opening is on each side of the transmission case. Frames are pressed steel channels ⅜ in. thick and 12⅛ in. deep at the center and tapering to the front and rear.

There are four springs at the rear end; these are semi-elliptic springs, one being mounted above and the other below the rear axle on each side. Both upper and lower springs are attached at the front to a swivel-beam equalizer, which equalizes torque and driving stresses from the upper and lower springs when power is applied. This rear-spring construction assures greater ability to absorb the enormous torque and driving stresses of the rear axle, provides improved cushioning for chassis and load, and makes possible the use of dual tires as large as 11.25-24 or 44 x 10 heavy-duty type and an overall width on the road within 96 in.



Model A-8 Chassis with All-Steel Cab

The rear axles are of the full-floating, double-reduction type with spiral-bevel gears in the first reduction and herringbone gears for the second reduction. Both new models are equipped with 4-wheel service brakes. The front-wheel brakes are of the internal-expanding, self-energizing, shoe type with a vacuum-operated booster. The rear-wheel brakes are of the internal-expanding, wrap-band type. When the standard International two-man cab shown in an accompanying illustration is used, it is built integral with the cowl, permitting the use of the improved three-point cab mounting. With the exception of the door framing, the cab is entirely of steel.

"Bitusprink" Announced

A new palliative, Bitusprink, has recently been placed on the market for use on roads and other dusty surfaces by the Bitusprink Company, 702 Fidelity Trust Building, Indianapolis, Indiana. This product is a liquid compound, containing varying per cents of bitumen, mixable, at the place of use and in any proportion with cold or hot hard water previously treated with a water compound, without noticeable separation, breaking or clotting.

When Bitusprink is added to the treated water, it makes a bituminous emulsion which can be sprinkled like water and when sprinkled on a wet or dry dirt, gravel, or stone road, penetrates into the roadbed. As the water evaporates from the emulsion, bitumen remains not on the surface of the road but in the roadbed as a binder. Bitusprink does not leave, on the surface of the road, a sticky mass which will get on automobiles, clothes, rugs, and floors, and it does not wash out of the road when it rains. Additional applications accumulate and in time bitumen will be sufficiently deposited in the roadbed to fill the voids and bind the road materials.

The emulsion made with Bitusprink is not only easily made with water procured locally, but the process of applying it is very simple. Water is placed in any kind of container, such as a sprinkling wagon or oil spreader, the water compound is added to the water and mixed with it, then Bitusprink, in any desired proportion, is added to the treated water and given a slight stirring. The emulsion is immediately made and is ready to apply, either by gravity or under pressure, on the road.

Bitusprink Dust Layer on Road South Out of Indianapolis Treated with 3½ Oz. per Sq. Yd.

New Wagon Tracks

A wagon track designed to fit any make of track wagon, new or old, has been announced by the Tractor Division of Allis-Chalmers, Milwaukee, Wis. Design, materials and workmanship of the new track are said to be the same as those used in Allis-Chalmers track-type tractors. Some of the features claimed for it are ease of pulling, the fact that it is self cleaning, use of materials which are constantly tested, and low price.

A four point support is provided for each track by two end wheels and two truck wheels. The track shoes, designed especially for wagon use, are made of heavy pressed steel. Links are drop forged and heat-treated to assure hardness and toughness. Pins and bushings are case hardened and so designed that natural wear does not effect the ease of pulling.

A strong one-piece frame supports the truck, track wheels and two end wheels. This frame is made up of welded steel plates rigidly braced by steel ribs which are welded on at points where the stress is greatest.

The track unit is mounted midway between the end wheels and truck wheels, and is free to pivot about the axles. A tube is welded into the side plates of the frame. It is fitted with bushings of various lengths and diameters, simplifying installation on wagons of various makes. Truck wheels and end wheels are mounted on roller bearings having spring compensating cork seals to keep the oil in and the dirt out.

These wagon tracks and parts are stocked by Allis-Chalmers track-type tractor dealers.

A Mechanical Spreader and Surfacer for Low Cost Roads

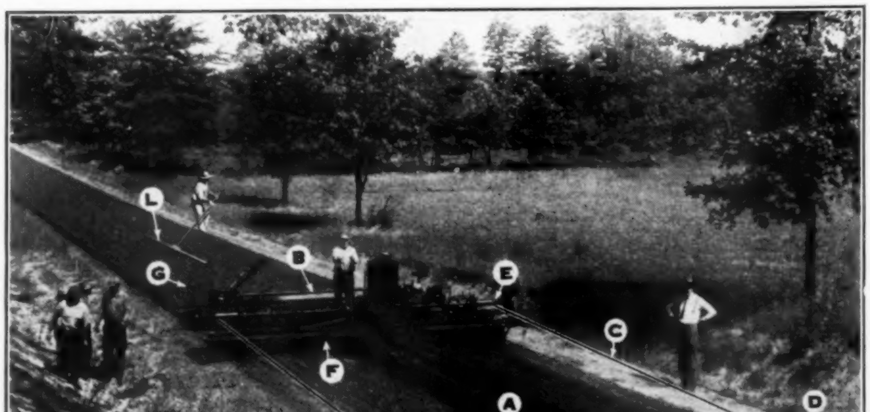
A power-driven machine for retreading, spreading and surfacing sand, asphalt or tar-bound surfaces has recently been announced by the Heltzel Steel Form & Iron Company, Warren, O. Referring to the accompanying illustration, the retreading material is placed in a windrow "A" along the center of the road and thoroughly "mixed-in-place" by the usual dragging and blading or "mixed-and-placed" method.

A blade or rudder in front of the machine deflects the material in windrow, when necessary, to the V-shaped spreader blade or rough leveler "F," which splits the windrow and spreads the material out to the side runners, set to the desired width of road. It is easily adjusted by means of hand operated adjusting screws from 2 in. to 8 in. depth of material; also by a single adjustment it is possible to tilt the spreader blade "F" to provide a rough crown.

The rear final leveling plate or keying member "B" consists of bucking board and leveling plate, adjustable to crown varying from flat to 3 in. by means of a single adjusting screw. This can be operated while machine is in motion. The advantage of this action is to allow constant change of crown while approaching or leaving flattened superelevated curves or flattened intersections. The height of the leveling plate "B" is regulated to different thickness of material by adjustable screw "G."

A pair of steel cables "C," approximately 300 ft. long and anchored at "D," are wound on two drums "E" at either side of the machine to pull it forward. The drums are operated at the same rate when working on the straightaway or can be operated independently when negotiating curves. After the cables are completely wound, the cables are again stretched along each side of the roadway and attached to an extra set of anchor plates, placed ahead of the one shown at "D," in which one or more stakes may be driven.

Side runners are of sufficient length to prevent dips in the finished surface. The manufacturer states that straight edging "L" illustrates the even spread of the material after one pass of the machine. The machine is stated to move forward under normal conditions at the rate of 12 to 22 ft. per minute.



Heltzel Mechanical Spreader and Surfacer